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The Punjab Past and Present

A Souvenir

of the

Twenty-Sixth Meeting

of the

Indian Science Congress Association

Held at Lahore

January 1939

EDITED BY

G. C. CHATTERJI, M.A., I.E.S.

INDIAN SCIENCE CONGRESS ASSOCIATION

TWENTY-SIXTH SESSION

LAHORE 1939

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INTRODUCTION

The Indian Science Congress met in Lahore exactly twelve years ago The years that have passed have seen many changes and improvements, but none in our climatic conditions. Those who visited us in 1927 will perhaps have forgotten everything connected with the Session, except the severe cold of our winter, and the consequent discomfort to many who are used to a warmer climate. But the Punjab inspite of its severe winter has a proverbially warm heart, and we assure our distinguished visitors of the warmth of our welcome, and of our appreciation of the honour that the Indian Science Congress Association has done us in accepting our invitation.

In 1927 the delegates to the Indian Science Congress were presented a small brochure entitled "Glimpses of the Punjab." The Handbook which we present to our visitors this year, is more ambitious, and its larger size and scope we trust, is a symbol of the progress which the Province has achieved during the years that have passed In the University itself there have been a good many new developments. An Honours School in Physics has been added and the scheme of higher teaching on the scientific side has thus been completed. An Honours School in History has been initiated, and a Master's Degree in Political Science established. A movement is now afoot to develop the higher arts teaching under University control and to establish a University Arts centre. A faculty of Engineering has been established, and degrees in Mechanical and Electrical Engineering are conferred on students who undergo their training in the Maclagan Engineering College, Moghalpura. The degree of Bachelor of Dental Surgery has also been established under a separate faculty of Dentistry, and the de Montmorency College of Dental Surgery, situated on the Ravi Road has been affiliated in this faculty.

A University Union has been built and appropriately named after our late distinguished Vice-Chancellor, Woolner Hall In front of this building and on a prominent site on the Mall now stands a statue of the late Dr. A. C. Woolner, a gift of Mrs. Woolner admirably executed by the eminent sculptor, Gilbert Ledward, R.A., the first public statue in Lahore in memory of a man who had devoted his life to higher learning. Several additional buildings have been erected on the University site such as the U. T. C. offices, additional rooms for the University office, the Kashyap Memorial Laboratory, and a hostel for the accommodation of visiting Mofussil teams participating in University Sports Tournaments. The University site is now becoming congested and presents a confused medley of inartistically grouped buildings It is hoped that it will be possible to expand the present site towards the small park, popularly called the Gol Bagh, but historically known as the Anarkali Gardens to provide room for much needed buildings already on the University programme such as the Laboratory for Technical Chemistry

The local first grade colleges affiliated to the Panjab University, excluding those providing professional courses, now number nine. The oldest of these, the Government College, was founded in 1864 and was affiliated to the Calcutta University, till the establishment of the University of the Panjab in 1882. It is situated conveniently near the University centre on the Kacheri Road. Its gothic structure placed on an eminence above the Anarkali Gardens, with its church-like spire is not altogether unimpressive. A new wing on the east side is now under construction which will house the library to be known as the Fazl-i-Hussain Memorial Library, after the distinguished Punjabi statesman and leader, the late Sir Fazl-i-Hussain. Out of the total estimated cost of one and a half lakhs of rupees, about half has been raised by public subscription, while the other half is being provided by Government. The College has a total strength of about twelve-hundred students and apart from providing teaching up to the M. A. standard in all Arts subjects, it houses the University Honours Schools in Zoology, Botany, and Physics.

The Forman Christian College, the next in the order of its foundation in 1886, under the control of the American Presbyterian Mission, is situated on an adjunct of the Mall, known as Robert's Road, which branches off from near the General Post Office The present buildings which are scattered about in a narrow congested site have long been considered unsuitable by the College authorities, and a new site on the Canal was acquired some ten years ago. Owing to financial stringency and difficulties connected with the disposal of its present property, the erection of the new building has been long postponed but the College hopes to shift its Intermediate Classes to the new site within a period of two years. This new experiment on the part of one of the leading Colleges in Lahore will be watched with interest by all its sister institutions

The Dayanand Anglo-Vedic College was founded by the Arya Samaj in 1889. This is located adjacent to the large hostel belonging to the Government College. The D A.-V. College Library contains a collection of interesting Sanskrit manuscripts, and the Managing Committee has recently started an institute of Industrial and Technical Training which is attached to this College. The number on the rolls of this College is over one thousand.

Three other large Colleges, the Islamia, the Dayal Singh and the Sanatan Dharam are a little further away from the University centre. The Islamia College was founded in 1892, the Dayal Singh in 1910 and the Sanatan Dharam College in 1916. Earlier than this the first Women's College, the Kinnaird was founded in 1913, at present located on Lake Road, but soon to move out to a beautiful site on the Jail Road, near the Canal, where building operations are in full swing, and on the completion of which Lahore will have one of the finest residential women's colleges anywhere in India. The Lahore College for Women founded in 1922 has already outgrown its present buildings acquired from the Boy's Cathedral High School, and is soon to move out to a more adequate site near the University playgrounds. The latest addition to the Lahore Colleges is the Sikh National College on the Amritsar Road, which has only just received affiliation.

In addition to these nine Colleges primarily devoted to liberal education, Lahore has a number of professional or special institutions which are more or less intimately connected with the University. The Law College, opposite the Senate Hall, and the Oriental College just behind it, are both University institutions. Mention has already been made of the Maclagan Engineering College, and the de Montmorency College of Dentistry. The Central Training College, the premier institution for the training of teachers, was founded in 1881, and the King Edward Medical College which along with its various laboratories and Hospital wards covers an area of over half a mile, is regarded by many as the best equipped and staffed of the Medical Colleges in India.

There are of course numerous High Schools and other educational institutions catering for the pre-university stage of education. Lahore is thus one of the largest centres of student life and activity, and the recent promotion of Intermediate or Degree Colleges in the Mofussil has in no way lessened the congestion of students in the capital city of the Punjab.

One noticeable feature of University education in recent years has been the phenomenal increase in the number of women students offering themselves for various University examinations. In addition to the two Women's Colleges mentioned above, several private Colleges for Women students have sprung up, and there is also an ever increasing influx of Women Students in Men's Colleges. Many of these young women are working for Honours or Post-Graduate courses, and have shown an aptitude for higher learning and for the extra-mural activities connected with University life, so as to threaten the ascendancy so long established by the male sex in the intellectual sphere. The Punjab may in fact congratulate itself on leading the way in the emancipation and intellectual and physical vigour of its women.

The Punjab because of its geographical position has never been the home of orthodoxy in the history of India. Though the last to be annexed by the British, it is perhaps to-day, more Westernised than any other part of India. But the Punjabi has always believed in getting the best out of the existing situation, and judging by our successes in the I.C.S. and other All-India Service Competitions, it is to-day maintaining not only its traditional ascendancy in physical vigour but also leading the way in intellectual and cultural advancement.

This volume entitled 'the Punjab Past and Present is an epitome ' of the life of this Province, presented in the form in which we trust it would be most appropriate for our scientific visitors. The first Chapter by Dr. K. C. Khanna, at one time lecturer in History at the Government College, Lahore, and at present Inspector of Schools, Multan Division, gives a bird's eye-view of the history of this Province. This is followed by a Brief History of the Panjab University from the pen of Professor J. F. Bruce, the University Professor and Head of the Department of

History In Chapter III Professor Bhatnagar presents a survey of the Scientific Teaching and Research conducted by this University. In Chapter IV Dr. L. C. Jain, the University Professor of Economics, makes an interesting survey of the Economic and Industrial Development of the Province. The next few chapters deal with Geology, Archæology, and Forestry in the Punja' followed by a brief account of Rural Reconstruction in the Punjab, all of which are the work of experts not directly connected with the University, and to whom we owe a debt of thanks not easily to be discharged. Equally are we indebted to Rai Bahadur Natha Singh, I.S.E , retired Chief Engineer, Irrigation Branch. for his excellent article on the Punjab Canals, and to our Vice-Chancellor for his masterly survey of Agriculture in this Province. The article on the Uhl River Hydro-Electric Scheme has been supplied by the Chief Engineer P.W D., Electrical Branch, to whom we owe our thanks, as well as to the General Manager, North Western Railway, who has not only supplied the very readable article with which this volume concludes, but also, at a nominal price, the maps with which it is illustrated. The admirable article on the History and Present Position of Medicine in the Punjab, is the contribution of Dr. Vishwa Nath of the King Edward Medical College and one of the most eminent of Punjab Physicians. Last but by no means least of all, we owe a debt of gratitude to Messrs. Uttar Chand Kapur & Sons, our publishers, who have carried out the printing of this volume free of all charges.

The work of an editor is never gratifying to himself, or entirely satisfactory to his numerous contributors. I have, however, received so much kindness and consideration from all concerned that I must indeed consider myself fortunate. I must not forget to mention Mr. Guran Lal Arora, M. Sc., University Demonstrator of Zoology, who has corrected all the proofs and who has been of the utmost help to me in seeing this volume through the press. If this Handbook, as now presented, is of some interest to the delegates to the Twenty-Sixth Meeting of the Indian Science Congress Association, all of us who have laboured towards its production will feel more than amply rewarded.

G. C. CHATTERJI

LAHORE,
21st December, 1938

CHAPTER I

THE PUNJAB THROUGH THE AGES.

BY

K. C. KHANNA, M.A., PH. D. (LOND.), F. R. HIST. S., M.R.A.S.

The Punjab with its Indian States covers an area of 133741 square miles. It is bounded on the north by the Himalaya mountains which separate it from Kashmir and the North-West Frontier Province, on the west by the Indus except for Isa Khel Tehsil of the Mianwali district and the district of Dera Ghazi Khan which lie across the river further to the west In the south-west this Province adjoins Sind the Rajputana desert lies on its southern boundary while the Jumna separates it from the United Provinces

In the north and north east of the Province lie the Himalayan ranges, while in the north and north-west lies the Salt range In the west, the Dera Ghazi Khan district is bounded by the Suleman hills The major portion of the Punjab, however, comprises of vast plains flooded by several rivers which fact has been responsible for giving its name to the Province.

This land of five rivers, the Jhelum, Chenab, Ravi, Beas and Sutlej, as it really stands to-day, is also partially watered by the Jumna on the south-east and the Indus on the north-west and the western boundaries. All these rivers, the sources of which lie in the Himalayas, flow in a southerly or south-westerly direction. Their courses are tempestuous over long distance in the hills but are even in the plains. In the summer when they are fed by the melting snows and rainfall they assume wide proportions and occasionally flood the plains nearby The Jhelum flood of 1849, the Indus floods of 1856 and 1858 and the Jhelum and Chenab floods of 1892, 1893, 1903 and 1928 are memorable in the history of this Province for having washed away many towns and areas In the winter these streams become much smaller The fertile loam left by the rivers in the flooded areas is generally of great value to the cultivators. The areas between the two rivers are called Doabs, so that there are five doabs named since the days of the Mughals. The five rivers from the Sutlej to the Jhelum join the Indus at Panjnad in the Muzaffargarh district and the combined stream continues its course through Sind to join the Arabian Sea at Karachi.

Physically the mountainous and the submontane regions and the arid plateaus of the Salt range are much smaller when compared to the vast south-western and southern arid plains bordering Sind and Rajputana. Naturally the scenery of the land is varied from the gorgeous snow-clad peaks of the Himalayas to the vast corn-growing plains of the Punjab and the scarce and stunted bushy growth of the arid plains bordering the desert country. Likewise there is great diversity of climatic conditions between the Himalayan, sub-Himalayan regions, the Indo-Gangetic Plain West and the dry regions, and extremes of climate are experienced.

Such in brief is the character of the land, the history of which we are now going to survey. It is necessary to realise at the very outset the importance of a geographical fact which has vitally influenced the history of the Punjab as well as the whole of India. That is the existence in the north-western mountains of a number of suitable passes which remove the isolation of India from the rest of the continent of Asia. Well protected by its sea-board from Karachi to Calcutta or even Rangoon in the days prior to the progressive maritime enterprise of the Western nations, India could enjoy complete immunity from foreign invasions, but for these passes in the north-west. The Khyber and Bolan passes have acted as the main gates of India, and have been letting into the Punjab from times immemorial all those people who found their way hither through force of natural or political circumstances. It has been shown that the Punjab was inhabited at one time by people bearing a possible kinship with the Australian aborigines. It is very difficult to state whether and when the Dravidians, who superseded these, came from outside as invaders. The discoveries at Harappa and Mohenjodaro, dating back to 2750 B. C., which indicate a pre-Aryan civilization, are most probably connected with the advance in the material arts of life which the Dravidians had achieved. Whilst the Dravidians occupied the plains of the Punjab, people of another race called Mongolians, who filtered through the passes in the north-east of India and gradually established themselves all along the outer ranges of the Himalayas, had made homes for themselves in the hill tracts of the Punjab and Kashmir. These two racial elements were already present in this Province when about 2500 B. C., the first hordes of the Aryans began to move eastwards and in course of time entered India through the north-western passes It is impossible to pursue at this place the warfare between the Aryans and the Dravidians which resulted in a superiority for the Aryans, but the Dravidians were not extirpated Nor is it possible to study the inter-action in the Punjab between the Dravidian and Aryan ideas of life, which ultimately resulted in Hinduism For this very reason, the Aryans of the Gangetic valley began to despise their Aryan brethren of the Punjab as a people who had made a compromise with the non-Aryans. We can only make a passing reference to the development of kingship and the necessary administrative machinery among the Aryans Many kingships continued to function on a small and limited scale, and there was as yet no movement towards Empire-building The Persian invasion of India in the 5th century B. C., however, brought the north-western portions of the Punjab and the lower Indus valley into the vortex of the great Persian Empire It would be of interest to remember that the Indian satrapies were considered to be the richest portions of the Persian Empire With its important position, the town of Taxila soon developed into one of the most famous cities of the east.

The Persian Empire decayed and succumbed to the force of Alexander in the latter part of the 4th century B. C. With the ambition of being a world conquerer, Alexander could not possibly help advancing towards India which held an important place in the mind of the Greek World of his day. The story of Alexander's campaign and conquest lies outside our present scope It is, however, impossible to overlook some of its important aspects. The Punjab in the 4th century B. C was held by several Rajas and free communities, whose military ferver was not inconsiderable. Alexander set about his task of conquest piecemeal and achieved it without great trouble, for the country as a whole knew no political unity. The Punjab remained under Macedonian rule for a few years, but it is quite possible that the Hellenic Empire and its organization of territory held out an example to Chandragupta Maurya who began his process of empire-building with the Punjab This great empire founded and maintained on strict military principles over-stepped the natural frontiers of India and for a time took away from the Punjab the strict position of a Frontier Province The next change in the fortunes of this Province was of a reverse character The Bactrian Greeks snatched and governed considerable portions of it from their capitals of Balkh or Kabul or even Taxila, after their country had been overrun by Scythian hordes from across the Oxus. The incursions of the Scythians, the Parthians and their Turkish successors, the Kushans, really form a tangled tale in which general students of Punjab history may be little interested It is, however, important to know that during this period the Punjab was being subjected to a walter of races and a clash of social, cultural and religious ideas This clash resulted in a synthetic compromise of ideas and practices which remained the basis of the Mahayana form of Buddhism and new Hinduism as spread by the great Guptas in the 4th century A. D and adumberated later on by the Brahmins in alliance with the Huns and Rajputs Buddhism, thus, gave place to Hinduism in which the Brahmins held great power, and in which the multiplicity of high and low gods was a distinctive feature and in which the caste system was maintained with artificial rigidity. The Jat tribes mostly of foreign origin mainly tilled the soil, the Rajputs, high and low, of Aryan and foreign stock, did all the fighting and governing. Such conditions lasted from about 600 A D. to 1000 A. D. during what is regarded as the Rajput period.

In the meanwhile Islam was finding its way into various countries of Asia When it spread to Afghanistan it lay next door to India. Its first contact with Hinduism was not peaceful. The Muslim invaders had many advantages in their struggles with the Hindu chieftains of the Punjab, consequently the Hindu kingdoms of the Punjab fell into Muslim hands in the early eleventh century and the Sultanate of Delhi was established with the strategic town of Delhi as its capital. The Muslim rulers did not have large numbers with them, nor did they have enough experience of Indian conditions, so the tribal system of local administration was mostly allowed to continue. The social habits of the rulers and the ruled naturally underwent mutual changes, and the physical fibre of the people of the Punjab, victors and vanquished alike, was much hardened by the unsettled conditions of political life and control.

From the end of the thirteenth century, the Mongols began to raid the more vulnerable portions of the Punjab, until Babar established the Mughal Dynasty in Delhi in 1526. It was not, however, until the days of Akbar and more particularly until the death of Mirza Hakim in 1580 A D that the Punjab was politically settled for any length of time. So long as the Mughal Empire remained strong, it not only preserved peace on the Frontier but also attempted to exercise political influence across the Frontier in Afghanistan With the decline of the Mughals, however, the country became very vulnerable to attack, and Nadir Shah and Ahmad Shah Abdali gave repeated blows to the tottering empire in the mid-eighteenth century.

Out of the embers of the Mughal rule in the Punjab rose the Sikh power which in the first half of the nineteenth century culminated into the Sikh kingdom of the Punjab The Sikh war-lords at the head of their followers at first began to exercise political control over small areas which subsequently took the form of Misls or confederacies. Then the process of cohesion began under the military genius of Ranjit Singh. He did not find his task very difficult. He was a born leader of man The Mughal rule was in a state of decay. Above all Sikhism had developed into a strong military theocracy under the leadership of the Tenth Guru.

Within about thirty years Maharaja Ranjit Singh began to rule virtually the whole of the Punjab (inclusive of N. W. F. Province) north of the Sutlej. His rule was, however, entirely despotic, and the ten years which elapsed between his death in 1849 and the annexation of the Punjab by the British in 1849 fully laid bare the hollowness and instability of a state governed by autocracy.

With its annexation to British territory, the Punjab became a definite part of the Indian Empire and lost its political connection with Central Asia which had for so long exercised an important influence on her history. And only within eight years of its annexation, did it give an unmistakable proof of its strength and stability : in a sense we might say that it saved the Indian Empire in 1857.

The development which this Province has made since its annexation to British India is great in many respects It has made rapid progress in the various administrative fields as the records of the different Government departments can show The contact with the European people, the introduction and rapid progress of the Western system of education and the consequent cultural changes in the habits of the people have influenced the life of the Province as no other century has ever done before The Punjab appears to be fast leaving the transitional period behind and is looking forward to an era of progress in which the thought and energies of all its people will be fully required. Its problems are complicated by the view points of the Hindus, the Muslims, the Sikhs and the Christians, who form the bulk of its population, but its hope lies in the fact that it has always learnt to receive hard knocks and to use the words of an eminent historian has been " trodden under foot to be trodden into shape "

This short sketch would not be complete without a reference to Lahore, which is the centre of the advancement of the Punjab It is situated on the left bank of the Ravi. At one time, the river flowed very near the city and the Fort, and was a source of danger to both. It was, therefore diverted northward in the mid-17th century and has since then caused little anxiety.

The name of Lahore, a corruption of Lahore, is traditionally connected with Loh, a son of Rama. The name appears to be common, as not so far from it, at

Amritsar there is the fort of Lohgarh, and there are several other cities of this name as well This city does not appear to have been founded earlier than the first century of the Christian era. Alexander's historians do not mention it, but Hieun Tsang who passed through the Punjab in the early part of the 7th century refers to it as a great Brahmin city between Sangla and Jullundur. The Ghaznavids conquered the Punjab and occupied Lahore in 1022 A. D. and probably founded a new town of Lahore to the northward of the old Hindu Lahore situated near Ichhra. From this time to its conquest by Ranjit Singh at the very close of the 18th century, it continued in Muslim hands as the city of an important provincial capital. It occupied a situation of great strategical importance as the highways from the north-west—one along the foot of the hills through sub-montane areas, and the other through the central portion of the Punjab---converged on it. The Highroad lying to the south of Lahore joining Kandahar and Quetta with Multan, Pakpattan, and Delhi was also important and was regarded by the Sultans of Delhi as the first lines of defence when the Punjab was politically disturbed in the early years of the Sultanate Lahore enjoyed a period of sunshine and glory under the Mughals, but with the decline of their empire, its condition deteriorated. It was an epitome of the decline in the whole Province in the 18th century During the first half of the 19th century under the Sikh rule, it enjoyed political stability, like the Province of which it was the capital. Engaged in the struggle for power, the Sikhs had no time to devote to architecture, besides they were not great builders. Still the city of Lahore gradually began to lose its air of 18th century decay and big *havelis* of nobles and officials were constructed here and there in every big city, more distinguished by size and massiveness than by architectural beauty With the coming of the British, Lahore began to make steady progress in this direction till by now it has become one of the finest towns in Northern India. During the last quarter of a century it has made wonderful progress in this direction for which the Government and private agencies are equally responsible.

Lahore possesses its due share of historical places and monuments but practically all of these relate to the Moghal period and after. There is, of course, the very modest Tomb of Kutub-ud-Din Aibak, the founder of the Slave Dynasty, constructed along a by-road of Anarkali Street. But the Shalamar Garden, the tombs of Nur Jahan and Jahangir at Shahdara, the Fort, the Badshahi Mosque, the Wazir Khan Mosque, Chauburji, the beautiful gateway to the now-vanished garden of Zeb-ul-Nissa, daughter of Aurangzeb, are great monuments of the 17th century. The tomb of Maharaja Ranjit Singh is not a very imposing building considering the greatness of the Sikh ruler. Since the Punjab became British, much has been done to increase the architectural greatness of Lahore. The Mall Road, with a large number of buildings, both public and private on either side, is a product of the British times and is considered to be one of the finest in India. Without fear of contradiction we might say that the Mall Road, with buildings within a distance of half a mile on either side of it, epitomises a great deal of what has been done to Lahore -nay the Punjab—during the short period of 89 years under the British rule in this Province.

CHAPTER II

A BRIEF HISTORY
OF THE
UNIVERSITY OF THE PANJAB.

BY

J. F. BRUCE, M.A., F.R.A.S

The University of the Panjab has existed in two successive forms. In the first phase it was a probationary institution, Panjab University College, kept under the watchful eye of the Government of India as an unwilling bond-servant of the University of Calcutta. During this servile period of thirteen years the University, besides fulfilling the terms of wardship, was active in protest against its tutelage and in preparation for the attainment of its maturity and independence. Since its main functions have been continuous from the beginning, we may, therefore, say that it has had two birthdays, namely, 8th December, 1869, and 14th October, 1882. Reckoning from its first era it is now sixty-nine years old; from its second, fifty-six years

Modern education in the Panjab traces its origin almost to the beginnings of the British Province in 1849 Schools were founded almost immediately by the Board of Administration, which as early as 1850 proposed to the Government of India the establishment at Lahore or Amritsar of a school of a partly collegiate character. The proposal was premature, but the interest of Government in higher education was apparent from the outset

This interest was greatly stimulated by Sir Charles Wood's famous educational despatch of 1854, which forms a landmark in the history of Indian education. It resulted in three striking measures: the formation of a Department of Education in every Province; the introduction of the system of "grant-in-aid" to educational institutions; and the foundation of the Universities of Calcutta, Bombay and Madras. The first and second of these measures were at once adopted in the Panjab, and the achievement of the third—a University—was entertained as a practicable ideal.

The Department of Public Instruction was established in the Punjab in January, 1856, and, despite the alarms of the Mutiny, by the end of 1858 the Province boasted about 1,150 village schools, while grants-in-aid helped to maintain several Mission Schools. Moreover, as early as 1858 the Director proposed the establishment of a Central College at Lahore. It was still premature, but by that year Normal Schools for the training of teachers had been founded at Lahore, Delhi and Rawalpindi. When British India passed under the direct control of the Crown in 1858, the foundations of education in the Punjab had been well laid.

In April, 1859, the first Secretary of State for India, Lord Ellenborough, issued another important educational despatch, concerned chiefly with the further development of Indian Universities. Two years later, in April, 1861, Sir Charles Wood, then Secretary of State, sanctioned the foundation of a superior school at Lahore. It was a mixture of a Government High School and a Chief's College in separate departments, and it foreshadowed the rise of higher education. In 1862 there were three first grade schools, besides several vigorous Missionary Schools. Of the latter, that conducted by Rev. J. Forman at Lahore was officially described as the best school in the Province.

Collegiate education in the Punjab actually originated on the professional side. As early as 1853 an "Anatomical School" was formed at Mian Mir. In 1857 the Civil Surgeon proposed its conversion into a Medical School, giving instruction in English and Hindustani, and a Medical College was in fact opened at Lahore in October, 1860.

A proposal had been under consideration for some time to open a Central College at Lahore, on the model of Presidency College, Calcutta. It had been forestalled by the Medical Service, but in 1863 it was sanctioned, and in the following year, 1864, Government Colleges were opened at Lahore and Delhi. Dr. G. W. Leitner, M.A., Ph. D. (Freiburg), formerly Professor of Arabic and Muhammadan Law at King's

College, London, was appointed Principal at Lahore, and Mr. E. Willmot, B.A. (Cambridge), at Delhi. Both Colleges prepared students for the examinations of the University of Calcutta. In 1866 a Mission College was also opened at Lahore for the same purpose. It was closed in 1869 and reopened in 1886 as Forman Christian College.

In its early years Government College, Lahore, did not prosper greatly. The education of each student was costing Rs. 1,200 a year, and in the First Arts Examination of 1866 there were 17 candidates from Government Colleges in the Panjab, of whom only 4 passed, including only one from Lahore. These facts evoked rebukes from the Lieutenant-Governor and from the Governor-General, which were apparently deserved, for four students had passed from the Mission College. The conditions did not seem to promise success for the project on this basis to erect a University. But Dr. Leitner emerged undeterred from his severe skirmish with Government. In January, 1865, he had founded the Anjuman-i-Punjab, a propagandist society, which aimed at establishing an independent University of the Panjab upon the basis of the general promise contained in paragraph 24 of the Educational Despatch of 1854.

There were, indeed, serious objections to the attachment of the Punjab Colleges to the University of Calcutta, on account of its unsuitable curriculum and methods of examination, as well as the fact that it was designed primarily to test the results of higher education in Bengal, where conditions differed greatly from those of the Punjab. Feeling on the question ran high. The Principal of Government College, Delhi, described the University of Calcutta as "the Arch-Inspector of Schools of Bengal" and as "an academic solecism." Dr. Leitner employed more direct and practical methods of attack upon the Calcutta connexion, which, he urged, produced in Punjab students a narrow, superficial and unreal knowledge, and divorced them from their own cultural tradition.

The Anjuman-i-Punjab, aimed among other things, at the revival of Oriental learning, education through the vernacular, and the "association of the learned and influential classes with the officers of Government." In response to an invitation of the Lieutenant-Governor, Sir Donald McLeod, in June, 1865, to propose means of improving modern education and literature through the vernacular, Dr. Leitner quickly produced a scheme for an "Oriental University of Upper India," which, in his excited brain, would produce "a new era, in which the *complete* results of science and learning will be imparted to the *whole* people." This scheme was approved at a series of public meetings, attended by native gentry and intellectuals, organised by Dr. Leitner and the Anjuman, and was also supported by an influential group of Englishmen which included Mr. (afterwards Sir) C. U. Aitchison, Mr. (afterwards Sir) Lepel Griffin and Mr. Brandreth, Commissioner of Lahore.

Funds were promised and collected to assist the realisation of this scheme of an Oriental University. The Viceroy, Sir John Lawrence and the Raja of Kapurthala each promised to subscribe Rs. 2,000 a year, Sir D. McLeod Rs. 1,000 a year. Other Indians and Europeans promised subscriptions and donations. The Lieutenant-Governor was actively sympathetic, but naturally wished the scheme to be reduced to a practicable form, which should promise success and gain the approval and sanction—as well as the financial support—of the Government of India. He consulted Major Nassau Lees, Principal of the Madrassa College, Calcutta, who advised caution and suggested, instead of an Oriental University, the establishment of a good college which, while conveying a practical knowledge of English and a general acquaintance with European science through the vernacular medium, should be based mainly upon the classical languages and literatures of India. It was a more modest form of Dr. Leitner's scheme.

Discussion of the general proposal and propaganda for its adoption continued during 1866, and in March, 1867, a strong Committee of Europeans and Indians was formed, which put forward a more balanced and practicable scheme for University and made a public appeal for funds to realise it. It should be noted particularly that the representatives of the Anjuman implicitly abandoned their original schemes and gave support to the newer and more general plan now proposed. The title now suggested was "Lahore University." When the Panjab University College became an accomplished fact, Sir D. McLeod, in his inaugural address on 11th January, 1870, explained the reason for the change. "The use of the term Oriental," he said, "did not commend itself to my judgment, as I deemed it certain that, without a large infusion of European literature and science, the object in view could not possibly be attained."

In 1867 the University movement in the Punjab received a fresh stimulus, when in August "The British India Association of the North West Provinces" proposed to the Government of India the establishment of a vernacular University at Delhi. The Government of India disapproved the proposal, but referred it to the Government of the Punjab for opinion. All officials and bodies in the Punjab to whom this proposal was submitted by the Lieutenant-Governor strongly opposed it and reiterated their approval of the proposal made by the European Committee in March, 1867, to establish a University at Lahore.

Meanwhile the Lieutenant-Governor had obtained donations of Rs. 62,500 from the Maharaja of Kashmir and Rs. 10,000 from the Raja of Kapurthala for the achievement of the local scheme, and these sums were placed in the general fund, while the Maharaja of Patiala placed Rs. 50,000, and the Rajas of Jind and Nabha each Rs. 11,000, in special trust accounts, which were paid over to the University College when it was actually established.

At a public meeting on 12th March, 1868, over which Sir D. McLeod presided, it was resolved that a University of the Panjab should be established at Lahore, which should be a teaching as well as an examining University, employing the professorial system and taking up teaching at the point at which the Government Colleges left it off. After some further amendment of the resolutions of this meeting the Lieutenant-Governor on 27th May, 1868, addressed to the Government of India a request for approval and sanction for the establishment of a University of the Panjab according to the plan submitted in his letter.

Despite the zeal which had been shown for the achievement of a University, the contributions had not been very great, amounting at the date of the Lieutenant-Governor's letter of 27th May, 1868, to less than one lakh. Of the amount collected, namely, Rs. 98,794, the Maharaja of Kashmir had donated Rs. 62,500; the Raja of Kapurthala, Rs. 10,000; the other ruling Chiefs Rs. 7,900; European officials Rs. 6,400; only about Rs. 12,000 being derived from ordinary public donation. Moreover, Rs. 12,589 had already been dissipated, and of the remainder only Rs. 7,337 represented the contributions of those who had wished to establish an Oriental University.

It is impossible in this brief account to record the voluminous correspondence and discussion in which the project at this stage was involved. The reader can examine it in the "Jubilee History of the University." A short outline must suffice. The Government of India was requested to approve a separate University of the Panjab and to sanction an annual grant-in-aid of Rs. 21,000. The special objects of the University were to be, " to afford encouragement to the enlightened study of Oriental languages and literatures, the improvement and extension of the vernacular literature of the Punjab and its Dependencies, and the diffusion of western knowledge through the medium of the vernaculars." Instruction and examination were to be conveyed *as far as possible* in the vernacular. Proficiency in a classical Oriental language, combined with a thorough knowledge of English, should be necessary in order to attain the highest honours of the University, but provision was to be made for honouring proficiency in literature and science in the case of those unaquainted with English, and in English in the case of those unacquainted with a classical Oriental language.

The proposal was referred by the Viceroy to his Council, which included Mr. (afterwards Sir) Henry Maine and Mr. (afterwards Sir) John Strachey. They did not approve the large scheme and suggested that support should rather be given to the extension and improvement of the teaching in Government College Lahore. In that sense the Governor-General replied to Sir Donald McLeod on 19th September, 1868.

The Lieutenant-Governor agreed that the proposal was defective and impracticable in certain respects, but on 12th November, 1868, he expressed to the Government of India his deep regret the refusal would completely discourage those who were zealous to secure a system of higher education in the Punjab. In consequence of his strong advocacy the Government of India sanctioned the establishment of the institution in a modified form, and this sanction was confirmed by the Secretary of State.

The new institution was to be called a University College, to indicate that its status was merely temporary and that, if it justified the promotion, it might, in future, be established as a University. It was empowered to grant certificates of proficiency, but not degrees. Certain conditions were definitely imposed by the Government of India, particularly (*i*) "that the study of English shall form one of the most prominent features of the teaching" and that "teaching and examination in subjects which cannot with advantage be carried on in the vernacular shall be conducted in English;" (*ii*) that in all teaching in the vernacular effective measures shall be provided to secure modern educational methods and standards.

The Anjuman, through Mr. Lepel Griffin, who, in Dr. Leitner's absence, was acting as president, expressed to the Lieutenant-Governor its keen disappointment at the decision of the Government of India, and pleaded that at least the name of a University and the power to confer Oriental degrees and titles of honour be conceded. Sir D. McLeod replied that it would be unwise to press the Government of India further at this stage, and that he had accordingly accepted that part of the scheme which they approved. He hoped that the successful conduct of that measure would soon justify the sanction of the complete scheme. On 5th August, 1869, the new Secretary of State, the Duke of Argyll, repeated the promise that "hereafter, if attended with due success, the College would be expanded into a University."

Accordingly, the Panjab University College was established by Notification No. 472, dated 8th December, 1869.

Before the establishment of Panjab University College the Anjuman had attempted to form an Oriental College. It opened schools in 1865, and in May, 1866, it experimentally set up a College and Madrassa of the proposed University. It was discovered in 1867 that the cost of these institutions was being met from the general fund which was being collected for the foundation of a University. They were closed by 1st June, 1868, but in the interval considerably more had been expanded upon them from the general fund than had been collected from supporters of the original scheme of an Oriental University.

As soon as the University College was founded the Executive Committee of its Senate took measures for the provision of an Oriental Department, which should provide instruction in the Sanskrit, Arabic and Persian languages and literatures, together with a modern training in the elements of general knowledge through the vernacular. In December, 1870, a budget allotment was made for an Oriental School, which from March, 1872, was called Oriental College.

In 1870 the Lahore Medical School became affiliated to the new University College, which in the same year also opened English and Vernacular classes in Law for the training of Mukhtars and Pleaders. In 1874 the examinations in Law were handed over to the University College to conduct under rules laid down by the Chief Court. The new institution had a name and a variety of functions—examining, teaching, encouraging the advancement of classical learning and vernacular literature by means of the grant of scholarships, fellowships and prizes—but for some years it had no local habitation. Its administrative affairs were conducted in a room of Government College, of which the Principal, Dr. Leitner, was its Registrar. The Oriental College was also housed in Government College, the Law School in a hired house. The remainder of the teaching connected with the University College was conducted by the Government Colleges at Lahore and Delhi.

In the year 1871-72 the University College granted scholarships, tenable at the two Government Colleges, to the total value of Rs. 8,400. This created a vexatious problem, which was not overcome until the University

College obtained the full privileges of a University at the end of 1882 ; for these scholarships were awarded on the results of examinations which it conducted. The Government Colleges were required to prepare their students for the examinations of the University of Calcutta, and Government scholarships were awarded on the results attained by candidates who appeared in the Calcutta University Entrance Examination. Since the great majority of students in those early days of higher education depended upon the grant of a stipend to enable them to pursue University studies, the two Government Colleges were compelled to prepare them for both series of examinations. The curriculum, the standard, even the date, of each of these series of examinations varied, and confusion prevailed in the two Government Colleges until in 1879 Government decided to award its scholarships on the results of the Panjab University College Entrance Examination. Even then Government College—for in November, 1876, the Delhi College was closed and its students were brought to Lahore—had still to prepare students for the higher examinations of Calcutta University which alone could confer the coveted degree, until at last, in October, 1882, the Punjab institution was raised to the status of a University and empowered to confer degrees.

Until too late Calcutta University had refused to modify its rules to meet the needs of Punjab students. Panjab University College did what it could to abate the nuisance of double examinations. It approximated its time-table, standard and curriculum of examinations as far as possible to those of Calcutta, but it could not deny its own *raison d'etre*, which was a protest against the general unsuitability of the Calcutta system for Punjab students, without seeking its own abolition; and that was now unthinkable.

Fairly steady progress was made by the University College throughout its existence. Only one branch of direct teaching was added to its functions after 1870, when, in 1873-74 classes in Civil Engineering were opened in the Oriental College. They appear not to have been very popular, for in eight years only 33 students appeared in the First Examination, of whom 15 were successful; while onlyone appeared in the Final Examination, which he passed.

Dr. Leitner reported in glowing terms the progress of Oriental College, though, if one may judge by its condition during the first five years of the University, he apparently saw it through rose-coloured spectacles. During the last six years of the existence of the University College a spate of volumes appeared from its press, for it possessed a printery of its own in these years. These volumes consisted mostly of vernacular translations of English text-books and of compilations and grammar books for the use of students. Few of them could be dignified as contributions to "the improvement and extension of vernacular literature," which was one of the avowed purposes of the College.

The number of candidates who appeared in the various examinations of the University College steadily increased. In its first Entrance Examination 88 candidates appeared, of whom 41 passed. In its last Entrance Examination 249 appeared, of whom 75 passed. In its first year 81 candidates appeared in all Oriental examinations, of whom 32 were successful. In the last series 399 appeared and 182 passed. During the first ten years 303 students appeared in all examinations in Law, of whom 151 passed. In 1882, 170 appeared, of whom 83 passed. The number of candidates in Medicine, remained fairly constant during the twelve years. The progress of the competition with Calcutta may be illustrated by the figures of examinations in the three years, 1878—80. In those three series 365 Punjab candidates appeared in all Calcutta University Examinations. In the corresponding series 910 candidates appeared in Panjab University College examinations.

Throughout the existence of the institution as a University College, its champions strove unremittingly for its elevation to the status of a University. Their attempt in 1873 was coldly rebuffed ; but it was renewed in 1876, when the next Viceroy, Lord Lytton, visited Lahore. On that occasion he promised to support the measure, and accordingly at the great Durbar of 1877 the Senate of Panjab University College presented a memorial praying for this enhancement of status. After much correspondence and the preparation of two draft bills, at last the Panjab University Act was passed on 5th October, 1882, and Panjab University was formally called into existence nine days later by a Notification issued by the Lieutenant-Governor, Sir Charles Aitchison. The first meeting of the Senate was held at Barnes Court, Simla, on 14th October, 1882, and almost its first action was to approve the Chancellor's resolution that the degree of Doctor of Oriental Learning be conferred upon Dr. Leitner.

The inaugural Convocation of the Panjab University was held in the hall of Government College on 18th November, 1882. It was a gorgeous ceremony, attended by the Patron, Lord Ripon. Its colourful splendour, as recorded by a rapt observer, suggests the emergence of the butterfly from its chrysalis.

One aspect of the development of the University during its minority period should be specially noted. Its creation and maintenance had only been made possible by the splendid munificence of the ruling princes of the Punjab, particularly by the Maharajas of Patiala and Kashmir, the Nawab of Bahawalpur, the Rajas of Kapurthala, Nabha and Jind and Nawab of Malerkotla, who donated very much the largest part of its funds.

A double University had been created by the Act of Incorporation of 1882. An Oriental University had been combined with an English University—a constitution unique in India. The two sides were given equal recognition and empowered to grant parallel series of degrees, while the Oriental Faculty received special powers to recognise proficiency by conferring Oriental titles and marks of honour. Thus, as had been advocated from the outset of the movement, both English and the vernacular languages were officially recognised, English becoming the medium of instruction and examination in all subjects organised upon the Europeon model.

Since its incorporation the University had passed through two main phases, firstly, between 1882 and 1904, and secondly, since 1905. The first phase was terminated by the passing of the Indian Universities Act by which its constitution and functions were considerably modified. The last phase has been marked not only by the attainment of its Jubilee, but also by the enquiry and report of a Committee appointed by Government to examine "its working, its constitution, rules and regulations with a view to suggesting such changes as may appear necessary."

The University was constituted under the Act of 1882 to act as (*i*) an examining body ; (*ii*) an advisory board of education for the Province ; (*iii*) a learned and literary society ; and (*iv*) a teaching corporation. Throughout its existence the first of these functions has remained the most prominent. The second was exercised progressively less as the organisation of the Government Department of Public Instruction was elaborated ; but at first the University was frequently consulted by Government upon general educational problems. The third function languished until Dr. (now Sir) Aurel Stein became Principal of Oriental College in 1888. Fourthly, as a teaching corporation it maintained the Oriental College and the Law School. All other instruction was conveyed by Government and private college, some of which were aided from the funds of the University, chiefly by means of the grant of scholarship on the results of its examination.

The University was empowered at first to confer degrees only in the Faculties of Arts and Oriental Studies, namely, Bachelor and Master of Arts and Doctor of Literature ; Bachelor, Master and Doctor of Oriental Learning. The caution of the Government of India, in proceeding slowly and gradually to endow the University with full powers, was wise, for during the first five years of its "majority" its organisation was found to be inadequate to its enhanced status. A general and radical reform was found to be necessary and was completed by 1888, largely by the devotion of Dr. (afterwards Sir) W. H. Rattigan, at that time Vice-Chancellor.

The general and financial administration, which had been taken over by the University from the University College, was found to be rather lax and irresponsible and was carefully overhauled between 1884 and 1887. In the latter year the Syndicate was reconstituted and made the effective executive committee of the Senate. Faculties were organised under responsible heads and a Board of Studies was appointed in each. The whole clerical staff was replaced and the Oriental College and the Law School were reformed. It was decided to appoint a responsible Registrar and, for the sake of economy, to select a qualified Orientalist, who should also be made Principal of Oriental College.

In 1888 Dr. (now Sir) Aurel Stein was appointed Registrar of the University and Principal of Oriental College. This distinguished scholar retained the dual office until 1899, and after an interval he was succeeded in 1900 by Dr. A. W. Stratton, who however, died in 1902. After another interval he was succeeded in April, 1903, by Mr. A. C. Woolner. During the period, 1882—1904, the Oriental College was the chief object of expenditure by the University for purposes of direct instruction. At the same time the balance between the eastern and western sides of the University was being rapidly altered. In 1901, for example, there were 403 candidates in all Oriental examinations, and 3,779 in those of Arts and Science. (In the most recent phase of development the disproportion has become vastly greater). On the other hand, certain members of the staff of Oriental College at that time, particularly Dr. Stein and Shaikh (later Sir) Muhammad Iqbal, made notable contributions to Oriental learning.

The Law School was similarly, though not so completely, recognised. The course of instruction was extended from two to three years. An English Barrister, Mr. P. Morton, was appointed part-time lecturer in 1887 and continued in that capacity till 1900, when Mr. Shadi Lal, M. A., B. C. I. (Oxon.) , Barrister-at-law (later Sir Shadi Lal, Chief Justice of the High Court of Lahore and now a member of the Privy Council) officiated until, in 1901, Mr. G. Serrell, M. A., LL. D. (London), was appointed Principal and the School was reorganised as a College. Dr. Serrell unfortunately died in 1904. In 1891 the University was empowered to confer degrees in law.

The Medical College has always been maintained by Government, the University merely providing the apparatus of examination. This college was also reorganised in 1886, when the University was empowered to confer degrees in Medicine. Its development since that time has been steady and continuous. In 1887 there were 48 candidates for all examinations in Medicine, of whom 12 presented themselves for titles in indigenous Medicine. In 1904 there were 596 students on the rolls of the College, which prepared them now only in the western system. Instruction in the Ayurvedic system was transferred to D. A.-V. College, in the Yunani system to Islamia College, Lahore.

All other instruction in this first period of the University was conveyed by Colleges which were "recognised" by the University. In 1882 there were only three such, namely, Government College, Lahore; St. Stephen's College, Delhi, which was opened in that year by the Cambridge Mission; and Mohindra College, Patiala, which had prepared students to the Intermediate standard since 1880, and achieved the status of a degree College in 1887. The two former Colleges prepared students for all examinations up to the M. A.

At the time of the general reorganisation of the University in 1886 several more Colleges were opened to prepare students for its examinations, especially the American Presbyterian Mission College, which has reopened, after a lapse of twenty years, as Forman Christian College. In the same year the Arya Samaj opened a school which, as the Dayanand Anglo-Vedic College, formed College classes in 1888. The Church of Scotland Mission opened a high school at Sialkot in 1886, which three years later formed classes in preparation for the Intermediate Examination of the University. Sadiq-Egerton College, Bahawalpur, had opened Intermediate classes in 1886 and advanced to graduate status six years later. In 1892 Islamia College, Lahore, was opened; in 1893 Gordon Mission College, Rawalpindi; in 1896 Khalsa College, Amritsar; while in the same year, 1896, Randhir College, Kapurthala, formed Intermediate classes. In 1899 Hindu College, Delhi, formed classes for the Intermediate, and in 1900 for the B. A. Examinations; while the Church Mission High School, Peshawar, which had been opened in 1855, formed a University Department—Edwardes College in 1900. Thus, at the end of the first period of the University twelve Arts Colleges were engaged in preparing students for its examinations. Before the end of that period another Professional College became affiliated to the University, which instituted a new degree to recognise the training which it provided.

In addition to the various Normal Schools which it had already established, Government founded a Central Training Collegein 1881. In 1887 it was removed to its present site, and in 1903 it was affiliated to the University to prepare graduate candidates for the degree of Bachelor of Teaching.

The progress of the University during this phase was also recognised in another way. In 1889 it was included by the University of Oxford in the list of Universities, the degrees of which Oxford recognised, and the graduates of which it admitted to certain important privileges. So Panjab University won its "hall mark." At the beginning of 1896 Cambridge extended to it the same recognition and privileges.

Having passed through a period which Sir Charles Aitchison described as a "false start," the University had established itself. Owing to the prevailing views and conditions, it had begun chiefly upon the model of London University as an administrative and examining machine and not, like other European Universities, as a corporation of scholars and students, conscious of their united quest after sound learning. But even before the end of the first phase indications of this proper attitude became plain. As early as 1891 the University had shaken off the Calcutta incubus. In the year 1902-3 a system of joint teaching was attempted by Government College and Forman Christian College. In the following year, 1903-4, the University received grants from the Governments of India and the Punjab for the erection of a suitable Hall and the provision of a sports ground. Since its incorporation in 1882 it had possessed a name but no habitation except the old Senate Hall, which it owes to the munificence of the Nawab of Bahawalpur in 1874. Its students lurked in corners of Government College and in hired houses. It was now, however, on the eve of a second era of achievement. Its greatest defect was that it was a more or less fortuitous assemblage of atoms of higher education. It still needs to become an organism.

The second stage of the life of the University, which was ushered in by the Commission of 1902 and the Indian Universities Act of 1904, has been a stage of formless achievement. Many good things have been attained, but they do not make a coherent pattern. We hope that that will be the essential contribution of the third stage.

The Indian Universities Act of 1904 was concerned chiefly with administration. It improved the composition of the Senate and of the Faculties, but it changed the mechanism more than the spirit of the University. It brought colleges apparently more under the control of the University by prescribing rules for their affiliation, though it did not sufficiently consider the needs and functions of the controlling body. It gave Government an opportunity to exercise an almost overwhelming authority in those controlling bodies, particularly the Senate. But its effect was not so great as might have been expected, because it was too largely mechanical, and this University has spent a good deal of energy in picking its way through the Act. But the Act enabled one very valuable measure, which, when systematically developed, will do endless good by transforming this University from a mere affiliating body into a genuine teaching corporation. The Act did another very good thing when it enabled the University to build, and all the building which ensued during this last period has been valuable, because it has created and developed its corporate consciousness. It is impossible to regard a body which merely regulates, examines, affiliates and gives degrees, as an *Alma Mater*. Early in this stage the University Hall and Library were erected and the Tournament Ground was provided. These form the nucleus, around which a true University will surely grow.

The new access of constructive development—which was not mere expansion, like the growing tally of Colleges and candidates for examination—received a fresh stimulus from the Congress of Universities of the Empire in 1912. It induced attention to University teaching. The first consequence was the invitation of a succession of distinguished teachers from other Universities to visit Lahore, review the existing teaching or their subjects, advise teachers, colleges and students, and suggest plans of development. They included Dr. Smithells, Mr. Ramsay Muir, Dr. Compton, Dr. Elton and Dr. Newton, between 1913 and 1929, and comprehended English, Arabic, History, Economics, Mathematics, Physics and Chemistry. If their direct influence seemed transitory, they have all left effective results in the University.

Another product of the new zeal was the erection and equipment of modern laboratories, which were placed under the direction of highly competent scientists. Government led the way here by extending the opportunities of the late Col. Stephenson, F. R. S., of Government College, who developed the departments of Zoology and Botany, which were placed at the service of the University. Honours Schools in these subjects were established. The University developed the system by adding, with Government assistance, an admirable department of Chemistry. In all these higher teaching and research have been ably promoted.

Oriental College was similarly developed. Research professorships of Arabic, Persian and Sanskrit were established. Honours Schools in these subjects were initiated and the Panjab University Oriental Publication Series was begun, while modern critical methods were applied in the new M. A. courses in Oriental Studies.

These advances were paralleled in the rapid expansion of the University Library, the establishment therein of a school for the training of librarians, and the acquisition of an important collection of manuscripts. The growth of the Library within this period has been one of the most admirable features of the development of the University as a centre of learning.

The progress of the University was affected somewhat at this point by the publication of the Report of the Calcutta University Commission, which had two notable results in the Punjab. On the one hand it resulted in the establishment by Government of a number of new institutions, called Intermediate Colleges, which were affiliated to the University. In the form which they assumed they have scarcely assisted in the proper development of the University, for they are suspended somewhat uncertainly between the schools and the University, without gaining the advantage of a strong association with either. Their value is movitory, for they have drawn attention to the necessity of considering the preparatory foundation of University education. The other notable fruit of the Report is the Academic Council of the University, which was created in 1923 and will, when its composition and function have been more thoroughly adjusted, prove one more valuable instrument for the improvement of the University as a corporation for the advancement of learning.

The decade from 1921 to 1930, that is, a period preceding a succession of lean years of financial depression and retrenchment, was marked by great and obvious growth. Not only has the admirable University School of Chemistry come into existence, as well as the subsidised School of Technical Chemistry at Forman Christian College, but also a crop of new and necessary University buildings has rapidly appeared. The Law College and Oriental College have been well housed, though the former has become utterly inadequate for the crowd of students who have thronged to it. Excellent hostels have been erected to accommodate students of the Colleges directly conducted by the University. Largely by the munificence of the late Sir Ganga Ram and the assistance of Government, a new professional institution, Hailey College of Commerce, has been established and well housed and equipped. Government also instituted modern Colleges, namely the Agricultural College, Lyallpur, and the Maclagan Engineering College, Moghalpura, for technical training and research, and these have been affiliated to the University, which has also established a department of Astronomy, with an observatory, under the control of a Reader. On the other side it has encouraged the systematic study of the vernacular languages of the Province and has undertaken the compilation of a Punjabi Dictionary.

The tale of rapid growth must record a very important step, that is, the inauguration of University teaching departments and the establishment of Professorship of Mathematics, Economics, Chemistry and History. The tale of these, we hope, has only begun, for their increase and organisation are a definite harbinger of a new era in the life and value of the University. The further extension of the policy which is plainly implied in their creation promises to provide the great achievement of the next generation. The problem of their proper relation to the governing councils of the University and to the affiliated colleges is crucial, and its wise solution will place the University in a far stronger and more useful relation to the life of the Province, which it must aim to serve as the great Universities of Britain serve that country.

Another important aspect of the recent development of the University has been the attempt to perfect a system of inter-collegiate instruction in post-graduate studies, in collaboration, where they exist, with the University departments, and the beginning, on the Arts side of the University, of a system of Honours Schools, corresponding to those of Science. The attempt at a Combined Honours School of English, Philosophy, Economics and History, admirable in conception, proved premature. A separate Honours Schools of History has been established, and it is hoped that it will be the forerunner of others, which can enter into balanced combination. The omens indicate an immediate development in the next phase, of those departments of social studies, which have been the great strength of the ancient Universities of England and the chief source of their civic and national influence.

The inception of a department of Physical Training in the University, which is one of its original advances among the Universities of India, is a further indication of the growth of its organic consciousness and its sense of civic obligation. It may be impossible to make a cult of physical fitness an object of academic study. but it is certain that the proper direction of the physical well-being of students is as vital as that of their social and intellectual training. This measure, with the erection of a Union building which marked the Jubilee, reveals the growing sense that the University must forget its artificial origin as a board of inquisitors, seeking candidates whom it might devour, and become an organic intellectual society, which will create social, political and intellectual leaders, while at the same time it contributes to the advancement of sound learning.

The year 1932 was specially notable in the history of the University, because of the completion of its fiftieth year in its full status, and also because of the appointment by the Punjab Government of a Committee under the chairmanship of Sir George Anderson to examine its present organization and operation and to advise measures for their improvement. The chief problems examined by the Anderson Committee were the form of the University, its administrative organization, its relation to the community, and its functions as an institution for higher teaching and the general advancement of learning within its Province.

The central recommendation of the Report (published in 1933) concerned the organization of the University as a teaching institution and advised a rearrangement both of its pre-intermediate courses and of the system of school education from which they take their departure. It proposed that the highest stage of school education should be incorporated with the Intermediate courses of the University in a system of Higher Secondary Schools of various types—literary, scientific and technical, from which the various Faculties of the University should recruit students, who should then proceed through a three years' course leading to the Bachelor's degree. This is the normal form of undergraduate instruction in universities outside of India and has been found generally satisfactory.

The Report strongly deprecated the heavy predominance of purely literary education in the University, which is constantly increasing the number of unemployed graduates, whose training at best fits them for a narrowly restricted field of livelihood, already overcrowded, and unfits them for diversion to other fields It urged the need of developing technical education in specially equipped institutions, which should assist to train craftsmen and agriculturists, as well as to provide more advanced technologists.

The Report also recommended the remodelling of the relationship between the nuclear University at Lahore and the various Arts Colleges both in Lahore and in the mufassal, and the reorganization of the governmental system of the University. But, apart from the piecemeal adoption of a few of its minor detailed recommendations which required no legislative amendment, it has so far produced no practical effect, for three main reasons—constitutional, financial and communal.

The University can only be reconstructed, under the present constitution, by an Act of the Government of

India and, in this period of transition, both that Government and Government of the Punjab are reluctant that it should enact such a reform. Moreover, the fundamental change in the nature and length of the B. A. course would involve a corresponding reorganization of the system of pre-University education and the establishment of a considerable number of intermediate institutions of new and various types ; both of which changes would require a heavy increase in expenditure. Lastly, reform of the University is hindered by the conflict of communal interests in the Province.

An epoch in the history of the University was marked by the death in 1936 of the Vice-Chancellor, Dr. A. C. Woolner, who had been concerned with its administration, in various offices, for a third of a century, having finally acted as Vice-Chancellor for more than seven years. Much of its most real progress in its present constitution is due to his wise guidance. Since his death it has suffered for nearly three years from the lack of an authoritative head, but with the appointment in October, 1938, of Khan Bahadur Mian Afzal Husain, we can hope for the restoration of the advantages of unified and continuous direction as well as for necessary organic reform.

The University has many problems to solve, among which perhaps the most pressing is the relation in which the nuclear institution at Lahore is to be adjusted to the affiliated institutions, not merely of Lahore, but also of the Provinces of the Punjab and the North-West Frontier and the adjacent States, which must receive their inspiration from Lahore. That relation cannot become really satisfactory until this nucleus becomes organic and effectively embraces the less richly organized institutions of the mufassal.

The largeness of its responsibility is indicated by the examination statistics of the year 1937, when the following numbers of candidates presented themselves :—

Matriculation*	...	22,513
Intermediate	..	5,977
B. A. and B. Sc.	...	3,656
M. A. and M. Sc.	..	383

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* Including 4,996 girls.

There are now 59 colleges incorporated in, or affiliated to the University in an area with a radius of about 400 miles from Lahore.

Despite many obstacles, the chief of which has always been financial, the University has achieved much of which its members may be proud, and it can look forward with temperate optimism, which will increase in proportion to its demonstrated value to the community which it serves.

CHAPTER III

SCIENTIFIC TEACHING AND RESEARCH

BY

S. S. BHATNAGAR, D. Sc.

A complete record of the scientific activities of the Province of the Punjab, which during the last decade or so have increased in many ways, requires a long time and much space. In the pages, however, which follow, it is proposed that a fairly detailed survey of the science laboratories at Lahore together with the historical sketch of research and teaching institutions be given.

This survey, however, will primarily concern the growth and organisation of higher teaching of science in the Punjab. References to junior teaching have only been made in brief as details of it have already appeared in 'Glimpses of the Punjab' published in 1927.

The details relating to the various sciences, *viz.*, Chemistry, Botany, Physics, Zoology, Psychology, etc., etc., are as follows :

The Teaching of Chemistry.

The history of the teaching of chemistry dates back from the year 1877, when Mr. J. C. Oman, F. C. S., was appointed Professor of Science in the Government College, Lahore. He founded the Punjab Science Institute in 1883 and this did excellent work in the promotion of scientific knowledge. In this work Mr. Oman was ably assisted by Lala Ruchi Ram, who obtained the first Master's degree in Physics and Chemistry in 1885. Mr. Oman retired in 1897 after 20 years' meritorious service. His place was taken by Mr. A. S Hemmy who held the professorship of Physics and Chemistry until 1906, when a separate professor was appointed for Chemistry. Mr. Mouat Jones—now Principal of the Manchester College of Technology, was appointed to this post, but he retired in 1912 on account of ill-health. Mr. B. H. Wilsdon took charge in 1913. He was fresh from the atmosphere of research at Oxford and infused a new spirit in the subject. He was responsible for the introduction of thesis carrying 100 marks out of 600 marks for the M. Sc. degree.

In 1913-14 Professor A. Smithells, F. R. S., of the Leeds University spent some months in Lahore at the invitation of the Panjab University. His stay and the course of lectures he delivered stimulated great interest in chemical research.

Soon after, Mr. Barnes of the Agricultural College, Lyallpur, and Professor (now Sir) P. C. Ray were also invited to deliver courses of lectures on the special subjects of their study.

It was soon realised that the conditions then prevailing were unsatisfactory from the point of view of research. Mr. Wilsdon, Professor of Chemistry, Government College, Lahore, prepared a scheme for an Honours School in Chemistry under the centralised control of the University with the co-ordinated assistance of the affiliated colleges. This was, no doubt, the result of Professor Smithells' visit.

In 1919 the University proposed to erect a chemical laboratory and to appoint a University Professor of Physical Chemistry. Mr Wilsdon, who prepared the plans had meanwhile left to join the Agricultural College, Lyallpur. Mr. H. B. Dunnicliff, who in later years played a unique part in the development and progress of chemical research in the Province, filled the vacancy.

In 1918 Mr. (now Dr) H B. Dunnicliff's services were lent to the Indian Munition Board. Bawa Kartar Singh officiated as Professor of Chemistry in Government College. During his stay of about 3 years he gave a fillip to research work.

In 1922-23, the University Chemical Laboratory was built at a cost of 5 lacs upon the plans prepared by the Government Architect, Mr. Sullivan, in consultation with Drs. H. B. Dunnicliff and B. K. Singh.

Meanwhile Dr. Dunnicliff had returned from the Cordite Factory at Aruvankadu and was appointed University Professor of Inorganic Chemistry in May 1924 in addition to his duties in the Government College.

In the following October, the writer of this article joined the University as Professor of Physical Chemistry and Director of the Chemical Laboratories.

In 1925, Dr. S. Krishna was appointed Reader in Organic Chemistry. He had a charming personality and made a deep impression on the students by his erudite learning and kindliness. He resigned his post in 1928 to join the Forest Research Institute as Biochemist. His departure was a great loss, but the University was fortunate in securing the services of Dr. J. N. Ray, a pupil of Professor Robinson.

The present staff is as follows:—

1. Professor S. S. Bhatnagar,
   University Professor of Physical Chemistry and Director, University Chemical Laboratories
2. Professor H. B. Dunnicliff,
   University Professor of Inorganic Chemistry.
3. Professor J. N. Ray,
   University Professor of Organic Chemistry.
4. Dr. N. A. Yajnik,
   University Reader in General Chemistry.
5. Mr. P. L. Kapur,
   Demonstrator in Inorganic Chemistry.
6. Mr. A. N. Kapur,
   Demonstrator in Physical Chemistry.
7. Mr. K. N. Gaind,
   Demonstrator in Organic Chemistry.

This staff is assisted by Professor P. C. Speers of the F. C. College, Dr. G. L. Datta of the D. A.-V. College, Professor Munir-ud-Din of the Islamia College and S. Mahan Singh of the Government College. But it is still inadequate to cope with the work of the increasing number of students in the Honours School. The immensity of the work would be realized, when it is mentioned that there are over 125 students in the various classes. These are distributed as follows:—

I Year Honours School	—	27
II Year Honours School	—	25
III Year Honours School	—	32
M. Sc. Research	—	20
Post M. Sc.	—	31

The academic work together with the work undertaken for some industrialists, a reference to which will be made later, is causing a considerable strain on the staff. They have, however, taken up the work cheerfully and are working in a more or less a missionary spirit.

Research work and other activities.—The writer of the present article did research work on surface chemistry dealing with the structure of matter and colloidal state, photo-chemistry and magneto-chemistry and during the last fourteen years since the institution of the Honours School published about 130 papers in collaboration with his students. He has devised a sensitive interference apparatus for measuring the susceptibilities of small quantities of substances which has since been manufactured by Messrs. Adam Hilger, Ltd., London. He has also written a book on Magneto-chemistry in collaboration with Dr. K. N. Mathur of Lucknow, one of his distinguished old students.

A Department of Petroleum Technology has also been inaugurated during recent years and the offer of Rs. one and a half lacs placed at the disposal of the present writer has been transferred to the University. A number of scholars are at present being paid out of this amount. It is gratifying to note that within two years Messrs. Steel Brothers have extended their research scheme for another five years and placed a further sum of Rs. two and half lacs at the disposal of the University. This has enabled the University to give the scholars the benefit of a Provident Fund, free medical aid and insurance against all risks.

Recently the present writer has been able to secure a grant of Rs. 7,000 a year for a period of three years from Mr. G. D. Birla. This money has also been handed over to the University to be spent on some industrial research. A number of other small schemes (Lala Shri Ram Scheme, The Ganesh Flour Mills Scheme, Tata Oil Mills Co. Scheme, Sir J. P. Shrivastava Scheme, Seth Padampat Scheme, Indian Mildura Fruit Form Scheme, the Lahore Electric Supply Co. Scheme) are also being investigated for their commercial possibilities.

Prof. H. B. Dunnicliff has investigated the action of oxidising agents on sulphuretted hydrogen and has published his results in a series of communications in well reported journals. His researches have found ample references in standard works and have been mentioned in the Annual Reports on the progress of chemistry. He has worked as a technical expert in some applied branches of this science. In 1928 he was appointed Special Chemical Adviser to the Central Board of Revenue and a Control Laboratory at present located in the Government College, Lahore, by the courtesy of the Punjab Government. The Government of India has, however, under consideration proposals for the establishment of a permanent laboratory at Delhi.

Through his untiring efforts, a Central Revenue Chemical Service has been created. This is a signal service to the Indian chemists and to the cause of chemistry in this country.

The work in the Control Laboratory has been instrumental in attracting the attention of Messrs. Steel Brothers to the Chemistry School at Lahore, the result of which has been the Petroleum Research Scheme of which the present writer is the Director.

Prof. J. N. Ray has been working on the elucidation of the stucture of some alkaloids. The new synthesis of quinazolines has been a real advance in the chemistry of this group. The synthesis of phthalazines worked out by Prof. Ray and his pupils has been extensively employed as a standard method of Rowe and others in settling ambiguous points in the Chemistry of these compounds. A series of papers have been published by the Department of Organic Chemistry on new synthetic substances designed to be effective in malaria and other parasitical diseases. An enquiry into the structure of vasicine—an alkaloid of *Adhatoda Vasica*, has been completed.

Dr. K. S. Narang set up the first Microanalytical Laboratory in India and has shown patience and skill in running it.

Dr. N. A. Yajnik, who was appointed as permanent Reader in General Chemistry in 1932, has been associated with the Honours School for much longer period. He has done considerable amount of work on the structure of gels and emulsions and obtained his doctorate from the Bombay University on the work done during his stay in Lahore.

Khalsa College, Amritsar.—When the Honours School in Chemistry was instituted, some of the colleges outside Lahore had grounds for anxiety. They realised that the teaching in the University which was being centralised was likely to affect them adversely. They feared that the Muffasil colleges would be reduced to second grade colleges and the most promising students would be attracted to the central place. The Khalsa College authorities, therefore, pressed very hard for permission to start the Honours classes there. The permission was granted. At present the students admitted at the Khalsa College are allowed to do the first two years of their work at Amritsar. But this is only a partial solution of the difficulty.

The Head of the Chemistry Department, Dr. Balwant Singh, is a distinguished product of the University. His services have been lent over by the Education Department to the Khalsa College for two years He has established a research centre in the institution and has already published a few papers.

Matriculation and Intermediate Teaching.—It was but natural that reorganisation of higher teaching of chemistry should have influenced the teaching of chemistry in the pass course, in Intermediate and Matriculation. The school and college laboratories are now much better equipped than they were 10 years back. The teaching has improved considerably and this is evidenced by the higher pass percentage. A great improvement has been effected in defining precisely the syllabus of these examinations. No books are suggested and this has naturally encouraged more general reading.

There has been a slight fall in the number of candidates taking up science in M. S. L. C. and chemistry in the Intermediate, but the number of candidates in B. Sc. pass has almost doubled. The following table gives the figures of the last ten years :—

Year	M. S. L. C.	F. Sc.	B. Sc.
1929	7325	1620	128
1930	7511	1739	102

Year	M. S. L. C.	F. Sc.	B. Sc.
1931	8090	1775	87
1932	7691	1791	100
1933	7656	1677	110
1934	6737	1634	151
1935	6578	1479	240
1936	6306	1434	249
1937	6271	1313	238
1938	6556	1414	213

The fall in the M. S. L. C. is due to the fact that candidates can now take up subjects in which they have the option to write answers in their own Indian languages. This option being not possible in sciences, the fall is understandable. There has been a very keen competition in the admissions to the Medical College where B. Scs. preponderate. This has resulted in the decrease in the number of the Intermediate candidates and corresponding increase in the number of B. Sc. students studying chemistry.

Irrigation Research Institute.—The history of chemistry in this Province would not be complete without a reference to the growth of the Irrigation Research Institute which was started in 1924 in a wing of the University Chemical Laboratories. Within the brief period of 14 years, this institute has earned a world-wide reputation for hydraulic and soil research.

The Institute was started at the suggestion of Mr. B. H. Wilsdon, who had already played an important part in the development of chemical research in this Province. The present Director, Dr. E. McKenzie Taylor, is also a chemist, whose researches on the origins of petroleum are quoted in standard works of reference in Petroleum Technology.

The application of modern chemistry to the scientific study of soils in this Province dates from 1930 when Dr. A. N. Puri, a brilliant product of the Panjab University, joined the institute as Physical Chemist and Head of the Chemical Section. Dr. A. N. Puri's researches have already resulted in the discovery of a cheap lining for our canals to prevent seepage losses.

The Government of India impressed with the work being done in his laboratory have placed at his disposal a special grant to enable him to carrry on researches on the improvement of earth roads in this country. He has achieved considerable success in this direction and some of his methods are actually being tested on a field scale. He is engaged in studying the causes of detriment of Punjab soils, the rise of water table and the movement of the salts and it is hoped that the solution of these problems will prove of immense value to this Province.

University Technical Chemistry Laboratory.

The University Technical Chemistry Laboratory is situated at the Forman Christian College, where the work has been carried on for a number of years under a contract between the University and the College. In view of the prospective transfer of the college to a site outside Lahore, it is expected that from October, 1939 the laboratory will be housed in an addition to the University Chemical Laboratory shortly to be built.

The equipment available covers a fairly wide range of apparatus used in the Chemical Industries, and compares favourably with the equipment available in similar laboratories abroad. Teaching is done under unit process plan, the emphasis being layed on the engineering side of the work. Elementary work in Civil, Mechanical and Electrical Engineering is carried out at the Maclagan Engineering College, under the particular charge of Dr. S. J. Kohli. The importance of the commercial side of industry is stressed, the M. Sc. Tech. Students taking a special course along these lines under Principal Thomas of the Hailey College of Commerce.

The M. Sc. Tech. forms one of the two avenues open to graduates of the Honours School in Chemistry. The department is further responsible for the teaching of a course in Descriptive Modern Industrial Chemistry, which is required of all Honours School in Chemistry Students.

The work in Industrial Chemistry was started in 1917 by the Forman Christian College first as a pass B. Sc. course which proved of great educational value, but little technical value on account of the little time available. In 1925 this work was changed to an Honours School in Technical Chemistry which carried on very satisfactorily for several years—and the graduates of this school will be found in many good industrial posts.

Up to this time, the University made a grant of Rs. 27,000 a year for the running of the school, and the college put in about the same amount in addition, as well as providing the laboratory.

In 1932 in view of the depression it was desired to reduce expenditure, and the present arrangements were made, whereby the two schools were combined and the more technical part of the work transferred to the present M. Sc. Tech. course the larger part of the expense for which is borne by the University.

Special emphasis has been laid on the Ceramic Industries from the beginning, since the Punjab is better off in these than in the raw materials for other industries. The Laboratory for this work was started by Mr. M. G. Bhagat, now Managing Director of the Bengal Potteries, and has been greatly developed and carried on for the past ten years by Prof. M. L. Joshi, who now has a well-equipped laboratory for the investigation of ceramic materials and small factory scale pottery work, in which excellent results are being obtained.

A new department is being made this year in a course specially designed for Public Health problems, under the particular charge of Prof. M. D. Bhalla, which is combining a number of different branches of work in this line.

Staff :—

Director—Prof. P. Carter Speers,
M. L. Joshi,
M. D. Bhalla,
Nazeer Ahmed,
Principal and Staff of the Maclagan Engineering College,
Dr. S. J. Kohli, M. E. College,
Principal, Hailey College of Commerce.

Physics.

The history of the study of Physics in the Punjab in the early days is closely connected with the teaching of Physics in the Government College, Lahore, where alone provision for preparing students for the M. Sc.

degree was made in the very early years of the inauguration of the University. This arrangement continued up to October 1934, when the Panjab University took up the teaching of higher Physics by the institution of an Honours School in the subject. This department of the University has been housed in the Physics Laboratory of the Government College, Lahore, under the headship of Professor J. B. Seth, Professor of Physics in Government College. The teaching is carried out with the close co-operation of the teachers of Physics of the various colleges in Lahore, the following taking part in the teaching work:—

1. Professor J. B. Seth, M.A. (Cantab), Govt. College, Lahore.
2. Professor J. M. Benade, M. Sc. (Princeton), F. C. College, Lahore.
3. Professor G. L. Datta, M. Sc (Pb.), Ph. D. (Gottingen), D. A.-V. College, Lahore.
4. Professor R. M. Chaudhri, M. Sc. (Alig), Ph. D. (Cantab), I. C. Lahore.
5. Dr. P. K. Kichlu, M. Sc. (Pb.), D. Sc. (Allahabad), Govt. College, Lahore.
6. Mr. B. D. Chhabra, M. Sc. (Pb.), Govt. College, Lahore.
7. Mr. Mela Ram, M. Sc. (Pb.), F. C. College, Lahore.
8. Mr. P. N. Kalia, M. Sc. (Pb), D. S. College, Lahore.
9. Mr. B. M. Anand, M. Sc. (Pb.), University Lecturer, Lahore.
10. Mr. F. C. Auluck, M. A. (Pb.), University Lecturer.
11. Dr. P. L. Kapoor, M. Sc. (Pb.), Ph. D. (Cantab), University Lecturer.

The development of interest in research in the subject is of comparatively recent origin. The beginning was made about 1924 since when the students of M. Sc. class began to devote their last academic year in preparing a thesis for the examination and soon after thesis was made a whole paper for the M. Sc. examination. Since then a fair amount of work has been carried on and a number of papers published in various Indian and Foreign Scientific Journals. With the provision of facilities and with encouragement and impetus thus received quite a number of persons have now grown up who are keen in advancing the boundaries of knowledge, and some of the laboratories in Lahore are well provided with excellent modern apparatus.

The Physics Laboratory of the Government College, Lahore, which also houses the University Department is equipped with instruments for specialised work in spectroscopy and workers are at present engaged in investigating the absorption spectra in the extreme Schumann region.

The Physics Laboratory of the Forman Christian College, Lahore, has been responsible for some excellent work on Cosmic rays which has been widely recognised. There is provision also for work in radio and several persons have interested themselves in this branch of science.

In the Islamic College, the staff of the Physics Department started work on the phenomena of conduction of electricity through gases under Dr. R. M. Chaudhri. But he has now gone away to Aligarh.

Botany.

Botany was taught in Lahore at first only as a part of the medical course. C. C. Caleb, M.B., B.S., Professor of Botany and Physiology in the Medical College, may be called the first teacher in Botany in the Province. Later the preliminary scientific classes for admission to the Medical College were discontinued and F. Sc. was made the minimum qualification necessary for admission to the Medical College. The first College to start F. Sc. in Botany was the Forman Christian College in Lahore in 1898 with Rev. J. H. Orbison as Professor of Biology. The Government College followed in 1902 with H. M. Chibber, M.A., as professor and opened degree classes in Botany in 1904. The first student who passed B Sc. with Botany was J. H. Mitter in 1906.

The first M. Sc. degree examination in Botany was held in 1909 and a private student passed the examination getting first class. He had also stood first in the B. Sc. in 1906 as a private student, but Botany was not a subject for his degree examination. This student who was formerly a medical practitioner in U. P. came to be the founder of the Botany School in the Punjab. He was Shiv Ram Kashyap. He will always be looked upon as one of the makers of modern Indian Botany. Before he had taken his M. Sc. degree he had contributed his first research paper in the Records of the Indian Museum in 1908. The degree with honours in Botany was for the first time awarded in 1911 and a student of Shiv Ram Kashyap, namely, Birbal Sahni, obtained that degree. These two botanists—one of the first M. Sc. and the other the first Honours graduate of the Panjab University—have brought honours to their country by their brilliant research contributions and have so to speak put Indian Botany on the map. Kashyap, who joined the Government College as an Assistant Professor in 1906, on his return from Cambridge, where he had proceeded on study leave in 1910, was appointed to the professorship in the college in 1912 and the same year regular classes in Botany for M. Sc. degree were started with three students, *viz.*, K. C. Mehta, S. L. Ghose and H. D. Kumar. The degree was awarded on the result of examination only In 1915-16 a research paper was also included in the course. The present Honours School was started as a University class in 1919 with Shiv Ram Kashyap as Professor and Head of the Department and S. L. Ghose and M. C. Sethi as his assistants. Birbal Sahni joined in 1920 as a professor from the University side. On Sahni leaving the University the designation of his post was changed and H. Chaudhuri was appointed to the first Readership in Botany in 1922. At this stage research in applied Botany was specially stressed and the University made a generous grant for equipment for research in Plant Pathology. Ghose returned from Cambridge in 1923 but left shortly for Rangoon on deputation for three years. On his return from Rangoon, research in Algology received a great impetus. The first batch of the Honours School M. Sc.'s came out in 1922. The old M.Sc. partly by examination and partly by research was continued till 1925-26 when it was finally discontinued. At present the M. Sc. degree is given on the result of research only. On the death of Kashyap on 26th Nov., 1934, we have not only lost a scientist who was respected all the world over, a teacher beloved by all his pupils but a great gentleman. The scientists in India conferred on him the greatest honour they had in their gift by electing him the General President of the Indian Science Congress in 1932 and the Panjab University conferred on him the degree of D Sc. (*honoris causa*). In his death research in Himalayan plants, especially of liverworts, had had a temporary set-back but his many pupils will no doubt carry on research work in this branch of science. One of his pupils, S. K. Pande, now in the Lucknow University, has been making valuable contributions on this branch.

Punjab has produced many eminent botanists. They are holding important positions in the Universities and in Agricultural Departments. The following Panjab University graduates have taken their Doctor's degree in this or some other University :—

P. L. Anand, Y Bharadwaja, G. S. Bhatia, G. S. Cheema, B. L. Chona, S. L. Ghose, A. C. Joshi, K. C. Mehta, M. Mitra, J. H. Mitter, R. L. Nirula, S. K. Pande, A A. Qureshi, G. S. Sachar, B. Sahni, B. L. Sethi, M. L. Sethi, H. Singh, J. J Singh, R. S. Vasudeva.

Present-day Botany.

Up to Intermediate standard, every student of Botany has to take up Zoology as part of Biology. Over 20 colleges in the Panjab University are teaching these subjects.

Botany for the Pass degree is taught in several colleges. The Khalsa College, Amritsar, Gordon College, Rawalpindi, and the Islamia College, Peshawar, are the three outside colleges where this subject is taught upto the degree standard. The students of all colleges in Lahore, excepting those from the Forman Christian College attend the University Pass Botany classes, held in the Government College Laboratories. The F. C. College, Lahore, does its own separate pass teaching.

The University Botany Department is located in the Government College Laboratories, and Dr. S. L. Ghose, Professor of Botany, Government College, acts as the Director of the Botanical Laboratories. Dr. H. Chaudhuri, the Head of the Department of University Teaching in Botany, acts as the Director of the Kashyap Research Laboratory of the University founded in 1936 and named after the late Professor Shiv Ram Kashyap of illustrious memory. This laboratory was built by public subscriptions and is meant for the use of post-M. Sc. students, research scholars and other research workers.

The Botany School is one of the oldest Honours Schools of the University. Here students prepare not only for the B. Sc. and M. Sc. Honours School degrees but also for Ph. D. and D. Sc. degrees of the University. Students appear for the B. Sc. Honours School degree after three years' study but pass graduates are given a remission of one year and are admitted to the second year class. The Khalsa College, Amritsar, has been given permission to teach the first two years of the Honours School classes. The students have to come to Lahore for their III Year B. Sc. and M. Sc. research work. Prof. Charan Singh is in charge of the Honours School, at the Khalsa College, and the Botany, Honours School, as a whole, is controlled by the Board of Control with the Head of the University Teaching Department as Chairman and five other teachers of the School nominated by the Syndicate.

The curriculum of the Honours School degree covers besides the old M. Sc. syllabus, special courses in Plant Pathology, Ecology of Plants, Soil Microbiology and Cytogenetics. Research students work under the guidance of either Dr. Chaudhuri or Dr. Ghose. Dr. Singh and Dr Anand also supervise research in certain cases. M. Sc. students have to do their research work at Lahore, but in special cases, permission to work outside Lahore may be given if it is found that for a particular piece of research better facilities occur elsewhere and a competent supervisor is available. At present one such student is preparing his M. Sc. thesis on recent plant fossils at Gorcon College, Rawalpindi, under Dr. R. R. Stewart. Facilities for research in the following branches are provided at Lahore :-- Plant Pathology and Physiology, Ecology. Algology (both fresh water and marine), Cytology and Cytogenetics, Soil Microbiology and Bryology. The research contribution made by the staff and the students are published in the various journals here and abroad. With the help of special publication grant from the University it has been possible to publish a certain number of monographic studies in the University Botanical Publication Series and already two volumes on Liverworts, one on Myxomycetes, one on Lichens, one on Diatoms and one on Lahore District Flora have been published.

The department possesses one of the finest collections of Himalayan Liverworts made by the late Professor Kashyap. It is also rich in its collection of mosses and ferns and flowering plants and also algal and fungal specimens. A fine collection of marine algæ from Karachi has been made by Dr. P. L. Anand who is studying the ecology of the marine algæ at Karachi. At Gordon College, Rawalpindi, Dr. Stewart has built up a fine herbarium of flowering plants from Kashmir and other Punjab Hill Stations.

The Government College Botanical Garden is at the disposal of the University Botany students. Students are taken out to the hills and seaside places to study the vegetation. The University Library is very much up-to-date regarding botanical publications in European Languages, and most of the important journals are subscribed. There is a departmental library, which is mainly a Government College Library, where, besides important books, the research students consult many of the journals and other important books periodically transferred from the University Library.

The following take part in the teaching work of the Botany Honours School:—

1. Dr. H. Chaudhuri, D. Sc. (London), M. Sc., Ph.D., D. I. C.
2. Dr. S. L. Ghose, Ph. D. (Cantab), M. Sc., F. L. S.
3. Mr. M. C. Sethi, M. Sc.
4. Dr. J. J. Singh, Ph. D. (London), M. Sc.
5. Dr. P. L. Anand, Ph. D. (London), M. Sc.
6. Mr. R. S. Chopra, M. Sc.
7. Mr. Basir Ali Sheikh, M. Sc.
8. Mr. P. N. Mehra, M. Sc., and some part-time demonstrators.

Zoology.

The early history of teaching in Zoology is common with Botany as in their early stages the two subjects were and are still taught together as Biology. Degree teaching in Zoology in the Punjab was started in Government College, Lahore, by the late Lt.-Col. Stephenson, F. R. S., in the year 1906, when four students were admitted into the III Year class for the B. Sc. course and in 1908 post graduate teaching for the M. Sc. degree was undertaken with one student. The period 1906—1915 may be said to be the early period in the history of teaching in Zoology in the Punjab. It was during this time that Karam Narain Bahl, Professor of Zoology at Lucknow, now Sc. D. (Oxon.), K. B. Mian Afzal Hussain, M. A. (Cantab), the present Vice-Chancellor and Dr. Baini Prasad, D. Sc., the present Director of the Zoological Survey, were students. The degree in these days was awarded on the result of written papers only.

The year 1915-16 marks first stage in the reform of teaching in Zoology, for it was during these years that thesis work was first introduced in addition to written papers. The year 1916 also marks the beginning of Inter-Collegiate teaching for it was in this year that B. Sc. classes in Government College were thrown upon to students from local colleges though students wishing to proceed to the M. Sc. degree could do so only by joining the Government College.

The year 1919 was marked by a further change in teaching of Zoology in the Punjab. This was the establishment of Honours School in Zoology by which the more intelligent and hard working student on passing the Intermediate Examination is admitted into the Honours Classes, and after studying Zoology for a period of 3 years appears for the Final Honours School Examination, the standard of which is the same as for the old M Sc. Examination. The M. Sc. degree is now given entirely on the results of a piece of research conducted by the student and usually it takes a year to 18 months for an average student to be admitted to the M. Sc. after passing the B. Sc. Honours.

In 1919 the staff of the Zoology Department was enriched by the presence of Dr. George Matthai, Sc. D. (Cantab)—later there were further additions to the staff Diwan Anand Kumar joining in 1921 and Dr. Vishwa Nath in 1927. The present staff is as follows :–

1. Professor G. Matthai, M. A., Sc. D (Cantab). F.L.S., F.Z.S., F.R.S.E., I.E.S.
2. Dewan Anand Kumar, M.A. (Cantab).
3. Dr. Vishwa Nath, Ph. D. (Cantab), M. Sc (Pb).
4. Mr. Dev Raj Puri, M. Sc.
5. Mr. G. L. Arora, M. Sc.

6. Mr. Najm-ud-Din Aziz, M. Sc.
7. Mr. Sukh Dyal, M. Sc.
8. Mr. Nazir Ahmad, M. Sc.

The number of students in Zoology has increased considerably during these years and in 1937 the students on the rolls for higher classes was 155.

The publication work of the Zoology Department received an impetus under the guidance of Dr. Matthai when in 1926 appeared the first number of the Memoirs of the Department of Zoology, Panjab University, and in 1931 the first number of the Bulletin of the Department of Zoology. We are receiving in exchange for our Memoirs and Bulletin publications from 103 Zoological Institutions in Europe and America.

Experimental Psychology.

Laboratories for Experimental Psychology are provided at the Government College, Lahore, Forman Christian College, Lahore and Murray College, Sialkot. Equipment for demonstrations in Experimental Psychology is provided at the Central Training College, Lahore.

The subject is included in the B. A. (Honours) courses and in the syllabus for the M. A. degree in Psychology of the Panjab University. Of the three Colleges teaching Experimental Psychology, the one at Sialkot is affiliated up to the B. A. (Honours), and the other two—the Government and the Forman—are affiliated up to the M. A. degree. For the M. A. they carry on the teaching jointly, the Government College providing the laboratory equipment and staff for the experimental and practical part of the course.

The initiative for the introduction of experimental Psychology, came from the Panjab University Board of Studies in Philosophy which evidently included at the time some enterprising psychologists. In June, 1921, Professor G. C. Chatterji, M. A., I. E. S., a distinguished Cambridge man who had then just joined as Professor of Psychology at the Central Training College, Lahore, reporting as an examiner, made suggestions for modernising the psychology courses of the University. The suggestions were well received. Soon after, Professor Chatterji was appointed Professor of Philosophy at the Government College, Lahore. He then himself joined the Board and was elected its Convener. About the same time, Dr. C. H. Rice who had returned to Lahore after a course of psychological training at Princeton (U. S. A.) and had been appointed Professor of Psychology at the Forman Christian College, joined the Board. Proposals made in December 1922 by Dr. Rice for the institution of an M. A. degree in Psychology, were strongly approved by the Board and referred to Professors Rice and Chatterji for scrutiny and report. Meanwhile a new syllabus for B. A. Psychology, prepared by Professors Rice and Chatterji, and providing for experimental demonstrations, was approved, and a revision of the syllabus in Intermediate Psychology taken in hand. In June, 1923, the Board unanimously recommended to the University the institution of an M. A. degree in Psychology. The M. A course was to be preceded normally by a B. A. degree with Honours in Psychology, while the Honours courses were to cover a study of the History of Psychology, the Elements of Experimental Psychology and a schedule of Practicals. The recommendations of the Board, which were eventually accepted by the University included General, Experimental, Social and Abnormal Psychology, Applications of Psychology to Education and Industry, a Practical Test, the usual Essay or, as an alternative, a Thesis for the M. A. degree in Psychology.

The Panjab University held their first examinations in B. A. Honours and M. A. Psychology in 1926.

After the University had taken the initiative, Professors Rice and Chatterji set about asking their respective colleges to provide for teaching in experimental psychology. At the F. C. C. accommodation and staff were provided and grants were made for the teaching of experimental psychology for the B. A. Honours and M. A. degrees. Professor Rice's Hindustani-Binet Performance Scale for the Measurement of Intelligence was published and interest in psychology began to spread. At the Government College, Professor Chatterji received much support from Principal A. S. Hemmy. Principal Hemmy, himself a scientific man of repute, in the course of his arguments with the Government Department of Education, wrote to say that psychology, in its modern aspects, was most desirable and that, among other things, it tended to deflect students of philosophical tastes from the arid tracts of scholasticism to the stimulating pursuit of science. On another occasion he wrote to the department saying that philosophers were now better employed than in merely criticising one another, they were endeavouring to put their subject on a scientific basis, the endeavour involved experimental work, and required apparatus and so on. As a result of these arguments, equipment and facilities for psychology at the Government College grew steadily, so that by the year 1929, the College had separate accommodation for the psychological laboratory, a lecture room and rooms for the staff. The laboratory was equipped with apparatus and appliances adequate for the teaching of experimental portions of the courses for the B. A. Honours and the M. A. degrees. These have been added to from year to year and the laboratory can now take in about six students every year for each course. The actual numbers, of course, are not so large.

In the year 1929 the psychology staff of the Government College was strengthened by the return to the College of Mr. Muhammad Aslam, M. A., after a period of study leave at Cambridge At the F. C. College teaching of psychology both for the B. A. Honours and the M. A. continued even after Professor Rice had left the College in 1928. At present their department of psychology is run by Dr. I. Latif, who has spent a period of study leave at Princeton (U. S. A.) and who has since his return developed a child and youth guidance clinic at his College. The Government College has contributed to general psychological theory, to methods of testing College freshmen and to the psychology of religion. Students with mental complaints are interviewed by the staff. The F. C. College has contributed to performance tests for Indian boys and girls and to methods of diagnosing and treating difficult children.

Engineering.

The Maclagan Engineering College, Moghalpura, the first engineering college in North-Western India, was established in 1923 by the Punjab Government. The Government of India, realizing development of the country and appreciating the engineering talent of the Punjabi had allotted a sum of Rs. 7,10,000 for engineering education in the Province, and the Mandi Hydro-

Electric Scheme provided the necessary final impetus for the Government of the Punjab to establish a first-rate engineering college in the Province.

The college opened on the 1st of October, 1923, in its own premises on a site covering 30 acres of land on the Grand Trunk Road, about four miles from Lahore, in the vicinity of the North Western Railway Workshops. The initial expenses amounted to over Rs. 10,00,000. The college buildings at that time consisted of the college main block with all the laboratories, classrooms, offices, etc., two hostels for the two classes and a number of staff bungalows. Although only 15 years' old at the present time, considerable additions have been made to the college in the form of extensions to the original buildings and the construction of new buildings. The latest addition is that of four bays of the college workshops on a site covering over five acres on the southern side of the Grand Trunk Road and opposite to the college main buildings.

The college is an institution for teaching primarily the sciences of mechanical and electrical engineering. A course in Civil Engineering is being instituted. To cope with the demand of industrial markets where not only engineers but also mechanics, electricians and artisans are required, the college has three different courses of instruction called the "A" course, the "B" course and the "C" course, respectively. Student who have passed the University Intermediate Examination with science and mathematics are eligible to join the "A" class and compete for the B.Sc. Engineering Degree of the Panjab University and the Diploma of the College, while those who have passed the Senior Cambridge Examination, the Chief's College Diploma, the Matriculation Examination or the Junior Cambridge Examination (but not the Intermediate Examination), are also admitted to this course but can sit for the Diploma Examination of the College only. All candidates seeking admission to the "A" course have to pass a competitive and qualifying entrance examination. The course is of five years' duration, three years being devoted to work in the college and two years to practical training in approved outside workshops or on works. For this period of practical training, the majority of the students go to the North Western Railway

Workshops, the Punjab Hydro-Electric Department and other Government Engineering Departments.

The diploma is recognized by the Punjab Government as a necessary qualification for admission to superior posts in its Mechanical and Electrical Engineering services—the First Class Diploma (with two-third or more of the maximum marks) exempting from sections A and B of the Associate Membership Examination of the Institution of Engineers (India)—(A. M. I. E., India)

The "B" course also extends over five years. The students admitted are usually those who have passed the Matriculation Examination, but admission is by a competitive examination and the passing of any other examination is not a condition requisite for sitting at the competitive examination. The "B" students work as apprentices for about nine months of every year in the North Western Railway Workshops, taking up particular trades which they follow later in their vocations.

Although primarily a vocational class, the "B" class provides the necessary training to enable those of its members, who possess sufficient ability and application, to pass the Associate Membership Examinations of the Institutions of Mechanical and Electrical Engineering, London. A number of these "B" students are successful in these examinations every year.

The "C" class is essentially a College Workshop Class. The training given is mainly in the college workshops, but is supplemented by a limited amount of theoretical instruction in elementary mathematics, drawing and engineering practice given at the college. The course is of two years' duration and aims at giving educated young men an introduction to a skilled trade sufficient to open up to them careers as artisans in which there is likely to be more scope for their success and advancement than that which is to be found in the overcrowded clerical occupations into which this class of young men are drifting at present in such great numbers.

The college laboratories are well equipped with up-to-date technical and scientific apparatus and machines. These include a testing laboratory with 100-ton testing machine besides other machines for carrying out all important tests on materials of construction, a hydraulics laboratory which has been recently extended and where the scope of work has been greatly enhanced, a heat engine laboratory with experimental steam engine, oil engine, Diesel engine, gas engine and refrigerating plant, an electrical instruments laboratory, an applied chemistry laboratory, a physics laboratory, an applied mathematics laboratory, a radio laboratory and other rooms such as battery room, wiring room, etc., where students obtain practical knowledge of the manipulation of machines, apparatus and appliances.

The Maclagan Engineering College staff counts among its members no less than 13 professors and lecturers who have British and Foreign qualification. Considering that the technical development of India is only in its elementary stage, and the consequent desirability of training abroad of the teaching staff of a first-grade engineering college is beyond all question, the possession of such a staff is a great asset to the college.

The physical development of the students is not neglected. All students have to take part in physical training three times a week. A qualified physical instructor is in charge of it. The college has clubs for tennis, football, cricket, hockey and volley ball. Lawns and grounds for all of these games are provided in the college compound. The college First-Aid team won the All-India Lord Reading Educational Institution's Challenge Shield in 1926 and the Lord Reading All-India Education Institution's Ambulance Competition Cup in 1927. Gurcharan Singh, the Olympic Hockey player, was a student of the Maclagan Engineering College.

A number of stipends and scholarships are awarded to deserving students. For "A" class there are:—

(*a*). A Dunlopsmith scholarship of Rs. 30 per mensem tenable for three years.

(*b*). Two Government scholarships of Rs. 50 per mensem (one for the first year and one for the second year) each tenable for one year.

(*c*). Two Government scholarships of Rs. 50 per mensem tenable for two years awarded on the result of the Final Diploma Examination.

For "B" classes there are 10 Government scholarships of Rs. 20 per mensem for each year and 15 Railway stipends, rising from Rs. 10 to Rs. 30 by increments of Rs. 5 every year, plus free board and lodging for Railway nominees of each year.

For "C" classes there are eight stipends of Rs. 8 per mensem for the First Year and eight stipends of Rs. 10 per mensem for the second year Hindu students donated by R. B. Lala Amar Nath.

Regarding employment after completing a course at the Maclagan Engineering College, students have met with great success. The college authorities are not aware of more than a few cases, where past students are without employment.

The North Western Railway is the largest employer of the old boys of the college and a number of old students of the college are now holding posts of foremen and higher administrative appointments. Other old students of the college have gone to other parts of India and are working in departments such as the Indian Posts and Telegraphs, other Railways, Customs, Hydro-Electric Departments of other Provinces besides the Punjab, engineering firms of repute, etc., etc.

CHAPTER IV

ECONOMIC AND INDUSTRIAL DEVELOPMENT OF THE PUNJAB

BY

L. C. JAIN, PH. D., D. SC. ECON. (LONDON)

I.

During the last two or three decades the Punjab has so developed in various directions that from the economic point of view she may be said to occupy no mean position in the country. According to the last Census of India taken in 1931, within an area of 136,964 square miles the Punjab (including States related to the Province) supports a population of 28,490,857 (208 persons per square mile), an increase of 13.5 per cent in one decade. The Punjab has a bigger area than Italy (119,691 square miles), a larger population than Spain (23,581,000) and a higher density than France (197). She stands fourth, fifth and sixth among Indian provinces in respect of area, density and population respectively. There are 50,691 villages and 222 towns in the whole of the Punjab and 34,630 villages and 177 towns in the British territory of the Province.

The fact is too obvious to need any emphasis that the economic and industrial development of a country presupposes and is the direct outcome of an all-round development in agriculture, forests, minerals, live-stock, means of communication, men and money

Agriculture.

Agriculture has for long been the main industry of the Province, and has undoubtedly received more attention from Government than industries in general. In 1937-38 the department of Agriculture spent nearly Rs. 31 lakhs as compared with Rs. 20 lakhs spent by the department of Indutries. In the same year the net area sown in the Punjab (British territory) was 32,643,277 acres out of which 11,497,298 acres were irrigated by State canals as compared with 9,678,000 acres in 1917 and 5,193,000 acres in 1900. The Punjab to-day has the largest irrigated acreage in the whole country.

Enjoying a variety of climates the Province grows a number of crops of which the most important are wheat (9,398,553 acres), cotton (2,909,152 acres), sugarcane (554,348 acres), gram (4,908,918 acres), maize (1,077,591 acres), barley (739,558 acres), and oil seeds (*toria* 418,256 acres and rape-seed 563,690 acres). Efforts are being made to improve both the quality and yield of all the products through research in various directions such as conservation of soil fertility, application of improved manures, selection of promising seeds, control of pests and diseases, consolidation of holdings and use of improved implements of agriculture.

The area under sugarcane is the second largest in the country, while of the area under cotton in 1937-38, the record area of 1,361,042 acres was under Punjab-American varieties But the most important crop of the Punjab is wheat and during the period of depression it has been the worst hit. It is gratifying to note that during the year ending 31st March, 1937, India exported 231,388 tons of wheat, almost all of which came from the Punjab, but it has been importing again from Australia, and now an import duty on wheat has been levied.

Fruits.

Fruit growing and fruit preservation are receiving special and increasing attention in the Punjab. A number of experiments are in progress and recently a canning hall and an experimental cold storage plant have been erected at Lyallpur. Fruit shows have been held at several places and a large winter fruit show in Lahore is now a regular feature of life in the capital. As a result of these efforts it is expected that new industries will develop and more products will be available on a commercial scale, replacing imported articles.

Forests.

Forests cover roughly 5·4 per cent. ot the total area of the Punjab. Of the area under forests only one-fifth is capable of commercial exploitation. Forest produce is divided into two main heads, namely, major produce, that is timber and firewood, and minor produce including bamboos, leaves, fruits, fibres, grass, gums, resins, barks, animal and mineral products. The importance of forests in the industrial development of a province may be evidenced from the flourishing furniture industry of Kartarpur and Lahore, the sports industry at Sialkot and the resin industry at Jallo and Hoshiarpur. There is, however, great scope for improvement in these industries. Recently the timber trade has suffered loss owing to the use by railways of iron sleepers in preference to wooden sleepers. The forest products need to be put to more economical uses (*e. g* , use of wooden poles by electric and telegraph departments) and research conducted on right lines. At present hardly 10 per cent. of the forest resources are utilised for productive purposes, while 90 per cent. go to waste.

Minerals.

The Province is poor in minerals. Rock salt, salt-petre and limestone for road building and cement making (Wah) form the most important products, while a small quantity of petroleum is also extracted. There are some small coal mines in the Jhelum, Shahpur and Mianwali districts, but the coal is not of very good quality. Gold washing is carried on in most of the rivers not without remunerative results, but as stated in the last Census Report, the mining of metals like iron, lead, silver, zinc and manganese is entirely unknown.

Power.

Lack of abundant supplies of coal constituted for long one of the greatest obstacles in the way of industrial progress in the Punjab, but this deficiency has now been remedied by the development of hydro-electric power. Provision of hydro-electric power bids fair to change the whole character of the steam into electric driven plants, and has made possible the establishment of several large new factories like the Lyallpur Cotton Mill at Lyallpur and the Steel General Mills at Moghulpura.

The Mandi Hydro-electric Scheme is one of the biggest projects of the world. The work was first started in February 1926 and the first stage of the scheme was completed in March 1933, when commercial supply of electricity was begun. This Uhl River Hydro-Electric project was opened by His Excellency the Viceroy, on the 10th March, 1933. The second stage of the scheme would raise the previous electric output to 72,000 K. W.

whilst the third stage would provide an additional 48,000 K. W.

Live-stock.

Like Agriculture, forests and minerals, adequate and healthy live-stock is equally essential for economic progress. According to the last quinquennial census of the Punjab Live-Stock, taken in 1935, almost all kinds of live-stock increased in numbers during the preceding five years. The number of bulls increased from 10,659 to 11,231, and of bullocks from 3,939,231 to 3,993,647, while male buffaloes advanced by 98,782 to 486,890. But it is important to observe that the increase in the number of bullocks and buffaloes has not been able to keep pace with the rise in the total cultivated area. The number per 100 acres sown fell from 20 in 1894-95 to 18 in 1913-14 and to 14 in 1934-35. The number of female buffaloes rose from 2,727,264 to 3,052,866 (12 per hundred of population as in 1929-30), while the number of sheep actually fell from 4,457,786 in 1929-30 to 4,424,147. The number of cows, however, rose from 2,418,444 to 2,653,056 or 11 cows per hundred of population in 1934-35 as against 10 in 1929-30.

According to the above census, there were 75,399 bulls, bullocks, buffalo bullocks, cows and female buffaloes used neither for breeding nor for work. Instead of being a source of wealth these animals are an undoubted drain on the grazing and fodder resources of the Province.

Communications.

Means of communication also play an obvious and important part in the economic and industrial development of a nation. The Punjab is cut off from the sea, but is a land of five rivers with excellent roads and a large net work of railways. Private enterprise in motor lorry service, to an increasing extent, is a distinguishing feature of recent times, but the railways still occupy the most prominent position as a means of communication.

That the development of railways is by no means unsatisfactory is evidenced from the fact that 400 miles of railway lines in 1872-73 have now increased to about 6,000 miles. But the development has been governed partially by strategic rather than commercial considerations.

It is only since the opening of the canal colonies that the latter aspect has received real prominence.

The development of roads also originated with the military requirements, but the progress has been equally rapid. The increase in the mileage of metalled roads amounted to 318 miles (from 2,619 to 2,937) during 1911—21, and to 1,136 miles or nearly four times as much in 1921 – 31. The total mileage of metalled roads during 1936-37 was 2,879 out of which 2,835 miles were tarred. At the same time the cost of maintenance per mile has been reduced from Rs. 1,700 a mile ten years ago to Rs. 1,250 per mile now.

A very considerable increase in traffic recently has made it imperative to increase the width of the metalled roads. According to the present development programme, it is proposed to spend a sum of Rs. 1¼ crores in eight years on the widening of the existing metalled widths. On the completion of the programme it is anticipated that the tarred and metalled mileage will be approximately 4,000 miles and there will be 10,000 miles of unmetalled but motorable roads.

Turning to rural transport it is interesting to observe that in 1935 as compared with 1914 the number of camels was practically stationery at 307,000, carts had increased from 302,000 to 357,000 but the number of donkeys declined from 701,000 to 663,000 and horses, mares and mules from 462,000 to 428,000. This decrease is presumably due to the increasing popularity of motor transport, while the increase in the number of carts may be accounted for by the increase in the produce of the land and its movement to market towns.

Water and Air Transport.

Water transport is negligible, since the Punjab rivers are constantly changing their course and are shallow in winter and much of their water is diverted to canals. Air transport is still in its infancy.

II.

Men.

Passing from the natural to human resources it is a truism to say that in the economic progress of a country the latter are even more important than the former. Other countries by the energy, initiative and enterprise of their people have become great and rich, while India has remained poor in a rich environment, thanks to the indifference of many Indians to material prosperity, to their lack of energy and their failure to adapt and initiate.

For a long time, the scarcity of both skilled and unskilled labour was a serious drawback in the economic progress of the Province. But times are fast changing and the Punjab probably possesses the finest human material in the whole country.

The Punjabi physique is superior to that of all other people of India and a Punjabi is less restrained by custom and tradition which impede progress in other Provinces. He travels more than other people and knows how to mix with others. The pressure of unemployment is leading to the growing realisation of the dignity of labour and an average educated Punjabi is fast shaking off the old sense of shame in working in a workshop or earning his livelihood as an honest craftsman or salesman. At the same time the instinctive bias of particular castes for particular industries is also losing its hold.

The Punjabi is known for his aptitude for engineering and he has already made his mark in railway and motor workshops all over the country. Recently he has turned to large scale industries—notably cotton, iron and steel rolling mills and chemical works and, if his present performances can be taken as some guide to his future achievements, the Punjabis with their enterprise and natural bent for constructive work are destined to play an important role in the industrial development of the country

Unemployment and Beggary.

A good deal of excellent human material, however, is at present unfortunately running to waste in various forms of unemployment and beggary. No reliable statistics of unemployment in the Punjab are yet available. Neither the census nor any department of Government provides figures of the unemployed and there is no unemployment insurance in India. But the number of educated persons without work is so large that for every vacancy of a clerk there are thousands of applicants and for every competitive post there are hundreds of qualified contestants. Unemployment of so many educated young men is a great national waste which is sapping the strength of the people.

The position of beggars is still worse. According to the last census there were 181,664 (including 22,704 females) beggars in the British Punjab, and the number must have appreciably increased since 1931 owing to the trade depression. In the course of his investigations Mr. Amar Chand Bhatia (Birla Research Scholar) has found that many beggars, before adopting their present avocation, were running small scale industries such as handloom weaving, carpet weaving, iron and metal wares, pottery, ivory goods and art ware and tanning. The Dhanak and Julah beggars who have settled in colonies in Lahore and elsewhere have been the most industrious workers on the handlooms and after heroic fighting against the demons of world wide depression, failure of trade and burden of indebtedness are at last reduced to beggary by sheer necessity. The Kashmiri beggars are still agriculturists and shawl-weavers for part of the year. The failure of crops, decadence of cottage industries and burden of revenues are responsible for many beggars from Bikaner side to wander from place to place and sometimes for their womenfolk stoop to low practices to make a living. Here is need for immediate state action and philanthropists and reformers can take a hand in rescuing all this human power for plenty of work which awaits them in trade and industry, if properly stimulated.

Unemployment and Industries.

Similarly there is considerable economic waste of human material in the provincial jails and it is sad to note that crimes in the Punjab are on an increase. Serious efforts are needed to turn the prisoners into useful members of society and train them in suitable industries so that on their release, they may be able to earn an honest living and not revert to crime. At present, apart from the printing press in the Central Jail, Lahore, the other main industries of the Punjab jails are cotton weaving (including all cloth for prison clothing), wool weaving (prisoners' blankets and coats), carpentry, cane work, paper making, grinding wheat, castor and mustard oils and tent making. At the Borstal Jail there is in addition a big tailor's shop and the inmates are taught tin-smith's work, painting and making shoes, footballs and leather suit-cases, while the women at the Female Jail are taught fine sewing and embroidery and hosiery work.

Money.

If labour in the Punjab was scarce and unsatisfactory in the past, capital was still more hard to procure. The savings of the people, specially Muslims who regard interest as unlawful, were hoarded in the form of ornaments while the Hindu capitalists employed their cash in commerce or money-lending. All this has changed in recent years, particularly after and probably as a result of the trade depression. Owing to a combination of causes the money-lending business has been most hit and there are signs that the economic urge and recent debt legislation are driving capital away from money-lending. This capital might well find profitable investment in manufacturing enterprises.

In England and other countries private bankers have played a prominent part in economic and industrial development. The indigenous bankers and money-lenders in India have the training and traditions of sound business. They have only to learn the modern methods to reap the rich rewards which still await the pioneers of industrial development in various directions.

State and Industries.

Industrial development in modern times presupposes not only peaceful conditions, but also a favourable economic policy. India has enjoyed peaceful conditions since the latter half of the nineteenth century, but the State had no industrial policy in that period. The industrial progress of the country in so far as there has been any progress, is a matter of the last two or three decades and may be said to have been stimulated by the recent advance in rapid means of communication, the war conditions and requirements of 1914—18 and the political reforms of 1919 under which the subject of industries was transferred and placed under the control of Indian Ministers.

Industries formed but a minor part of governmental activities in the Punjab before 1919. It was in 1920 that a separate Department of Industries was established and a sum of Rs. 3,50,912 was spent during 1920-21 out of which Rs. 1,97,732 was absorbed in the construction of the building of Maclagan Engineering College, Moghulpura. Subsequent years witnessed the passing of the Punjab Industrial Loans Act, establishment of an Arts and Crafts Depot at Lahore, provincialisation of District Board and Municipal Industrial Schools and increasing provision for industrial instruction.

In the years of depression, when more might have been spent on industries, the total expenditure of the department was actually reduced from Rs. 11,27,896 in 1930-31 to Rs. 10,22,602 in 1931-32 and to Rs. 9,44,018 in 1932-33. Since then, however, there has been a gradual increase to Rs. 20,31,504 in 1937-38.

This work of the Department comprises :

(*a*) direct encouragement to industries in such forms as industrial research work, provision of technical advice, assistance to industrialists by securing concessions and help in marketing, financial assistance, and miscellaneous help such as in the establishment of demonstration factories :

(*b*) collection and distribution of commercial and industrial intelligence, conduct of special enquiries and special surveys, holding of industrial demonstrations, exhibitions, etc. ;

(*c*) technical and industrial education to provide skilled and trained labour and supervisors to meet the needs of trade and industry.

Industrial and Technical Education.

No country can progress industrially without a programme of industrial and technical education which must, of course, be accompanied by a rise in the standard of general education. According to the Census of 1931 there was 9·5 per cent. literacy among male and 1·5 per cent. among females in the Punjab.

At present, there are 33 Government Industrial Schools and Technical Institutes for men and boys and 3 Industrial Schools for girls. In addition to these, the

Department of Industries gives grant-in-aid to 11 boys and an equal number of girls, institutions. The Government institutions impart instruction in modern methods of production on semi-commercial scale under the guidance of qualified technical experts. In the beginning, the aim was to turn out literate skilled artisans for already existing trades, but in 1932 the policy was changed and efforts were begun to introduce new industries, reform old industries, and to equip persons for modern industries.

A number of schools have been reorganised with a view to specialising in some particular line and producing articles of daily utility. For instance, the Metal Works Institute, Ambala, specialises in pump and internal combustion engine building and in automobile repairing ; the Industrial School at Gujranwala has taken to tool making on modern lines : the Industrial School at Jhelum provides instruction in wood and folding furniture ; the Industrial School at Jhang-Maghiana specialises in lock making by modern methods; the Industrial School, Kasur, gives training in leather work ; the School at Kulu concentrates on wool weaving and blankets ; the Government Technical School, Lahore, instructs in electro-mechanics and die sheet metal work ; the Industrial School at Rawalpindi provides training in basketry and the School at Lyallpur in the manufacture of agricultural implements by modern methods.

The importance of industrial training of women in the Province was specially recognised in 1927 by the establishment of a separate women's section in the Department of Industries and the consolidation and centralisation of all work under a whole-time Industrial Inspectress. The crafts taught in the Industrial Schools for girls include dress making and tailoring, coarse and fine hand and machine embroidery, *salma* and *tilla* work, hand knitting, toy making, laundry and cooking.

Among other crafts proposed to be introduced in girls' industrial schools or in which training may be provided by means of peripatetic demonstration parties, mention may be made of dyeing, bleaching, dry cleaning and calico printing, specialised weaving and carpet weaving, weaving of *newar* and *durries*, weaving of *sari* borders : sports net weaving and making of shuttle cocks, and basket cane and straw weaving.

In addition to these institutions, several peripatetic demonstration parties have been set up to train existing cottage workers in modern methods of work and in the use of up-to-date tools and appliances at their very doors. Five of these parties which are operating at Kalabagh, Palampur, Fazilka and Abohar, Muzaffargarh and Leiah, concern cotton and wool spinning and weaving and carpet weaving while one of them has a branch establishment for imparting training in *munj-ban*, mat and rope making operating at Kot Sultan. A glue makers' demonstration party is working in Rohtak, a tanning demonstration party at Chakwal and a demonstration party for the improvement of vegetable and essential oils at Rohtak. A wool teasing and carding station has been established at Kulu. A travelling women's demonstration party is working at Kulu while a party for imparting training in domestic handicrafts has been recently set up at Taxila. Similar demonstration parties to help the village blacksmiths, dyers, potters, silk cocoon rearers, *ban* and rope makers, etc., etc., will shortly start functioning in various parts of the Province.

Industrial Research.

Industrial Research in the Province began with the opening of an Industrial Research Laboratory at Shahdara on 8th November, 1931.

The Laboratory undertakes research into raw materials with a view to their economic exploitation and industrial utilisation, experimental work to help the existing industries and to solve problems concerning manufactures referred to it by industrialists, analytical work on behalf of the public and Government departments, and provides technical advice and assistance to Government departments and the public.

Subject to accommodation being available, the Laboratory takes in a few students for training in chemical industries.

It is gratifying to note that the research work done by the Laboratory has been instrumental in the establishment of a number of small industries such as sand paper manufacture (Universal Sand Paper Mills, Rawalpindi), starch (Eastern Products Company, Batala), paint and varnish manufacture (Ravi Paint and Varnish Works, Shahdara), pottery (Punjab Pottery Work, Limited, Jhelum) and artificial slates and pencils (Punchnad Pen Factory, Shahdara).

In addition to the above concerns, as a result of the experimental work done at the Laboratory and the advice rendered by the Industrial Chemist, the following industries have been set up in the Province:—

1. Absorbent Cotton and Anti-septic Dressing Company, Limited, Amritsar.
2. Punjab Celluloid Works, Ichhra, Lahore.
3. Modern Industries, Amritsar.
4. Miscellaneous Chemical Industries, *viz.*, disinfectants, toilet goods, oil refining, soap manufacture, ink and other articles of stationery.

The industrial institutions are also of late being encouraged to undertake research on problems connected with the crafts or trades in which they impart instruction. For instance, the Central Weaving Institute, Amritsar, has devised a new loom or weaving mosquito net cloth which has proved very popular and is being generally adopted by the co-operative societies.

The Panjab University Chemical Laboratories by their research have also contributed to the development of several industries in the Province to which reference in detail is made in an earlier chapter. In the Economics Department of the University surveys of several industries have been carried out.

Technical Advice.

Technical advice is provided to the general public through an industrial research laboratory, and a number of experts maintained by Government such as the Textile Inspector, hosiery expert, tanning expert, dyeing expert, weaving superintendent, (power loom weaving), oil demonstrator.

Financial Assistance.

Under the Punjab Industrial Loans Act of 1923 a total amount of Rs. 8,27,450 had been advanced to 219 applicants until March 1936 with a view to helping cottage and small scale industries. This Act was repealed in 1935 and replaced by a more comprehensive Act. Under the Punjab State Aid to Industries Act of 1935, State aid may be given to an industry to be newly established in an area where such industries are undeveloped; a cottage industry or an industry which needs revival or development by modern methods and what is even more important the State may guarantee a certain minimum return on the capital invested in an industry. Under this Act a sum of rupees two lakhs was distributed among 35 out of 100 applications during 1937-38. In seven cases (manufacture of spare parts of machinery and agricultural implements, weaving, manufacture of bottles, absorbent cotton, paints and varnishes, hosiery and manufacture of brass locks, iron sheets and buckets) the loans varied from Rs. 15,000 to Rs. 30,000, while among other industries helped were sports goods, manufacture of electric fans, rubber goods, surgical and veterinary instruments.

In addition, subsidies of Rs. 3,000 and 4,000 were given for the manufacture of sewing machines and electric goods respectively and a sum of one thousand rupees was sanctioned for the supply of machinery on the hire purchase system for the manufacture of badminton and tennis nets.

In four cases the Board of Industries recommended the guaranteeing by Government of a return of 3½ per cent. for a period of five years on the capital proposed to be raised by the applicant companies.

Industries (small scale).

We may now proceed to consider the present position of industries in the Punjab. Taking the small scale industries first, they are the special need of India, and the Province of the Punjab has a large number and great variety of them.

Handloom Weaving.

Among the cottage industries handloom weaving must rank as the oldest and the most popular. In recent years the handloom weaver has been faced with unprecedented competition from foreign countries particularly Japan and also from the Indian mills. As a result there has been a considerable fall in the production of fine muslin and *pugree* cloth for which Rewari and Rohtak were so noted. Similarly the woollen blanket weavers of Panipat have suffered from the competition of cheap Italian and Indian mill-made blankets. The spun silk weaver has, however, made good progress. Thanks to the *swadeshi* movement and the demand for *swadeshi saris*, shirting and *chaddars*, the pure and spun silk weavers thrived well for a time, but with the introduction of staple fibre yarn by Japan in the Indian markets early in 1937, the production of spun silk goods fell oft considerably. The staple fibre yarn has proved very popular on account of its silky feel and cheapness, but it is now being realised that the cloth made out of this yarn is not durable and in consequence its popularity is likely to be short lived.

Carpet Weaving.

The carpet industry of Amritsar is well-known not only in the country, but also abroad. In recent years, however, Amritsar has lost much of its trade with U.S.A. During 1932-33 only about 50 looms were working with 200 weavers as against the normal 300 looms and 1,500 workers. In the following years, however, the position improved in consequence of the preference given to Indian carpets in the English market under the Ottawa Trade Agreement. In 1936-37 1,000 weavers were working in 200 looms and it is estimated that the exports of carpets to United Kingdom and Canada increased by over 70 per cent. in 1937-38 as compared with the preceding year.

The carpet industry of Multan provides employment to about 30 cottage weavers who produce cheap varieties of carpets and *asans* (small carpets for sitting) for local consumption in the Province. The fine carpets of Multan are now a thing of the past.

Hosiery.

Another very important and flourishing cottage industry of the Punjab is hosiery for which Ludhiana, Jullundur, Amritsar and Lahore are well known. In 1932-33, however, the manufacturers of cotton hosiery goods failed to withstand the cheap Japanese, German and Chinese goods and a large number of factories remained closed in summer. Recovery, however, set in as a result of the introduction of up-to-date power driven machines and enhancement of duty on imported hosiery, although the recovery was small owing to a fall in prices by about 20 per cent. in 1934-35 as compared with the previous year. Since 1934-35, however, progress has been fair and the value of goods produced in Ludhiana alone amounted to Rs. 60 lakhs in 1937-38. Considerable improvement has been affected in the designs and finish of the articles and a line of growing popularity and promise is the production of cotton underwear and pullovers for which there is a large demand in Calcutta and Southern India.

It is disconcerting to observe that the hosiery industry is also threatened with over-production, but hosiery manufacturers have turned their attention to organised marketing as well as production which augurs well for their future.

Sports Goods Industry.

Sialkot has for long been famous in the country for sports goods which have attained a high standard of manufacture and enjoy not only an all India but now an international market. The export trade received an additional stimulus in 1933-34 by the preference given to it by the Empire countries. The main items of export are football covers, tennis and badminton rackets and cricket and hockey balls. The foreign demand, however, is mostly for cheap quality goods and internal competition has tended to lower the profits of the industry. According to the latest report of the Director of Industries large consignments of badminton rackets, shuttlecocks and badminton nets were made to the United States of America, the Far East Countries and the Continent, while the United Kingdom proved a good customer for ply-bent tennis frames. Cricket and hockey balls, cricket bats and hockey sticks were exported to South Africa, New Zealand, Australia, Rumania, the United Kingdom and a few other countries.

Iron and Metal Ware.

The iron works and foundries at Lahore, Amritsar, Batala, Jullundur and Ambala continue to progress. The new lines include the manufacture of tower bolts and motor piston sets and chromium, nickle and silver plating. The Lyallpur foundries have attained great success in the manufacture of chaff-cutters, ploughs, hoes, sugarcane *belans*, hand saws, etc., which are largely used in the canal colonies.

The safe making industry of Gujranwala, the brass and bronze ware industry of Jagadhri, Panipat, Bhiwani, Farrukhnagar and Rewari, the steel trunk making industry of Sialkot and Gujranwala which flourished before the depression all suffered for a time on account of over competition and the diminished purchasing power of the agriculturist. But recently there has been reorganisation and some rationalisation.

The iron safe industry of Gujranwala is mostly run by educated persons who have improved the quality and design of their products and introduced new articles such as fire-proof cabinets and steel shelves for which there is an increasing demand in offices.

The brass and bell metal utensil makers of Rewari and Farrukhnagar are gradually changing over from cottage to factory lines and the brass and bronze workers of Gujranwala, Daska and Sialkot are increasingly employing labour saving devices and machinery and gaining at the expense of cottage workers in Qila Sobha Singh and Pind Dadan Khan who still persist in using the older methods of production.

The manufactures of brass cocks and water pumps at Jullundur and Gujranwala and of the ærated water machinery at Amritsar have been doing well.

Cutlery and Surgical Instruments.

Cutlery is an old and famous industry of Wazirabad and Nizamabad, while the manufacture of surgical instruments at Sialkot is of recent origin. Still more recently (1932-33) the manufacture of safety razor blades was started by the National Manufacturing Works, Amritsar. In 1934-35 the production of surgical and veterinary instruments at Sialkot increased in value to Rs. 1,10,000 (from Rs. 90,000 in 1933-34), thanks to the decline of German imports as a result of unfavourable exchange. In the same year the Metal Industries, Lahore Cantt., placed on the market their first production of cutlery goods on a commercial scale which compared favourably in price and quality with imported articles. By 1937-38 the production of surgical instruments had risen in value to Rs. 2 lakhs and a recent feature is the installation of chromium plating plants with a view to giving improved finish to the products. The well-known firm of Messrs. Ghulam Nabi & Sons, Lahore, is doing extensive work in this line.

Pottery.

Glazed pottery was once a flourishing industry of Multan, but it has gradually declined— owing to the import of cheaper and more attractive looking wares from Japan and Czechoslovakia. The industry is now limited to a few hereditary workers at Multan, Amritsar, Jhang-Maghiana and Gujrat who produce decorative flower vases, bowls, dishes, tomb-stones with Arabic and Persian inscriptions, flowered tiles, etc. The tile making factories of Lahore, Pathankote and Amritsar, however, have succeeded in producing tiles of attractive designs which compare well with some of the best quality of imported tiles. The Northern India Tile Factory, Lahore, produces beautiful articles such as cement garden seats and decorative garden columns surmounted with flower-pots, while the fire-bricks factory of Lahore Industries, Ltd., is producing high quality fire-bricks which have been supplied to the North Western Railway.

Ivory Goods and Art Wares.

The above at Leiah in Muzaffargarh district, Amritsar and Hoshiarpur have made little progress since the years of depression. In Leiah alone the production fell to a third from Rs. 30,000 in 1932,33 to Rs. 10,000 in 1933-34 and the general demand for products of art industries and articles of luxury has continued to stand at a low level. In 1937-38, however, there was an increase of about 12 per cent. as compared with the previous year in the export of ivory goods and art wares to foreign countries, particularly Great Britain and Canada.

Tanning.

Tanning is an old industry of the Province fallen on evil days on account of severe competition with cheap leather imported from Cawnpore and Agra and the dumping of cheap Czechoslovakian and Japanese shoes which have tended to replace country shoes in the local markets. Of the four tanneries in the Province, the Northern India Tanneries, Shahdara, ceased working in 1937-38, but the Wazirabad Tannery, Wazirabad, and the Upper India Leather Works, Sialkot, have been producing buffalo calf leather which is in great demand in the districts of Rawalpindi, Attock, Mianwali, Shahpur and Gujrat and in the North West Frontier Province. Very recently a small scale tannery has been opened at Ferozepore by an old student of the Government Tanning Institute, Jullundur, and the report on its working is quite encouraging.

Miscellaneous.

Among other small scale industries mention may be made of the manufacture of glue in Rewari, woodwork in Hoshiarpur, the furniture industries at Lahore, Kartarpur and Gujrat, basketry, dyeing and calico printing carried on in several places.

Joint Stock Companies.

We may now turn from cottage to large scale industries in the Punjab. One of the indications in the rise of a nation in the industrial scale is the growth of Joint Stock concerns where capital and labour come together. In this respect there has been steady progress in the Punjab since the War. Taking the statistics of the last three years, there were 786 Joint Stock Companies at work in 1935-36 with a paid-up capital of Rs. 3,75,32,682 while in 1937-38 there were 1009 companies whose authorised capital was Rs. 60,39,85,238 of which Rs. 7,58,34,552 was subscribed and Rs. 4,59,51,866 was paid up.

Factories.

Confining ourselves to factories, the number in 1921 under the purview of the Indian Factories Act was 297 with 42,428 employees. The progress was well maintained up to 1928 when the trade depression set in There was a general feeling of uncertainty and suspicion and serious stagnation of trade and industry. In 1928 the number of factories had nearly doubled since 1921 while the number of operatives had risen to 51,613. In 1929 the number of factories fell from 559 to 521 and the employees to 49,875 and the corresponding figures for 1930 were 526 and 49,549. The number of factories actually working in the calendar year 1931 was only 506, most of those closed being cotton ginning and pressing factories on account of the poor cotton crops of 1930-31 and 1931-32. Since then, however, there has been improvement. The number of registered factories increased from 673 in 1932-33 to 712 in 1933-34 and the number of factories which actually worked from 515 to 576. In 1934-35 there were 730 factories registered under the Indian Factories Act, in 1935-36 the number improved by 24 and in 1936-37 by another 48, the total employees having risen in the meantime to 63,962.

The number of registered factories in 1937-38 was 862, while the number of factories which actually worked was 798 with 69,473 workers. It is interesting to observe that new floatations in 1937-38 included 19 cotton ginning factories, 8 hosiery factories, 15 textile concerns for weaving shawl and *loi* cloth, woollen and silk fabrics, 5 foundries, 10 oil mills, one toilet and chemical works and one factory each for the manufacture of electric fans, brass corks and water pumps, acids and chemicals and celluloid and tin toys.

Big Industries.

Industries connected with cotton easily lead the rest in the Punjab. There are 371 ginning, bailing and pressing factories for cotton spread all over the Province, but most of them are in Lyallpur, Multan, Lahore, Hissar, Ferozepore and Ludhiana. Dhariwal is famous for the woollen textile industry. In all 426,579 people are dependent on textile industries and 57,088 on trade in textiles.

As compared with other Provinces the Punjab does not stand very high even in regard to the cotton industry which is badly hit by the depression and the severe competition from Japan. Due to the latter reason the Bankteshwar Cotton Mills had to clcse down on 31st March, 1933. However, the progress made in recent years is remarkable. Two large scale factories were opened in 1934, the Punjab Textile Mills, Montgomery, and the Cotton Mills, Lyallpur The latter is equipped with a ginning plant and 25,000 spindles and 500 looms and is supplied with electric power from the Uhl River Hydro-Electric Scheme. The latest important addition is the Sutlej Cotton Mills opened at Okara in February 1937.

In the first table below are given quantities (in lbs.) of yarn of all counts spun in the Punjab as compared with that spun in other Provinces :—

	1933-34	1934-35	1935-36	1936-37
Punjab	2,570,562	2,699,641	7,118,486	9,034,865
Bombay Presidency ...	484,714,674	523,044,052	548,806,151	512 882,434
Madras	98,274,069	103,765,667	113,614,684	129,886,202
United Provinces	93,865,034	99,701,305	108,020,179	115,002,739
Bengal .	39,912,399	41,056,056	40,991,244	38,064,475

The number of spindles and looms in operation in the Punjab and other Provinces during the year ending 31st August, 1937, and the preceding two years were as under:—

	Spindles.			Looms.		
	1935	1936	1937	1935	1936	1937
	(figures in 1,000)			(figures in 1,000)		
Punjab ...	89	88	94	1·4		--
Bombay Island	29,90	29,85	28,90	68	68	67
Ahmedabad ...	20,20	20,42	19,76	50	51	49
Madras Presidency ..	9,76	10,91	11,51	6	6	6
Hyderabad ...	1,26	1,24	1,25	2·1	2·1	2·1

The production of twist and yarn can be gauged from the following figures:—

	In million lbs.				
	1932-33	1933-34	1934-35	1935-36	1936-37
Punjab ...	5·3	2·6	2·7	7·1	9·1
Bombay Presidency	559	485	523	549	513
Bombay Island ...	313	243	265	305	277
Ahmedabad .	166	169	179	166	163
Madras ...	105	98	104	113	130

The following table gives the quantity of the various counts of yarns produced in the Punjab Mills as compared to those produced elsewhere during 1935-36 :—

	(In million yds).					
	No. 1 to 10.	No. 11 to 20	No. 21 to 30	No. 31 to 40	No. 41 & above	Total
Punjab ...	2·3	6·3	0·5	—		9
Ahmedabad ..	1·8	61 2	40 6	34·1	25·4	163
Madras	2·7	55·2	38·6	27·7	3 9	130
Bombay Presidency ...	50·2	193·0	143·3	76·7	48 8	513

The following two tables give the quantity and length of *grey and bleached* and coloured piece-goods : —

	1934-35	1935-36 (in million lbs.)	1936-37	1934-35	1935-36 (in million yds.)	1936-37
Punjab ...	2.2	5·6	6 4	6 9	18·5	21 4
Ahmedabad ...	131	115	118	724	658	653
Bombay . Presidency ..	342	352	354	1,701	1,801	1,749
Bengal	30·0	30 3	32·0	145·2	145·7	153·2
Madras ..	9·3	10 1	10 5	33 3	41·3	41·9

	Coloured goods.					
	1934-35	1935-36 (in million lbs.)	1936-37	1934-35	1935-36 (in million yds.)	1936-37
Punjab ...	8	52	349	40	258	1,579
Ahmedabad	52,817	47,480	48,776	325,989	298,974	310,900
Bombay Presidency ...	105,030	108,408	107,346	582,522	605,684	598,208
Bengal ...	605	412	584	3,132	2,125	2,944
Madras ...	11,587	10,232	10,386	36,835	34,137	34,947

Sugar.

As a result of the grant of protection to the sugar industry in 1931 for a period of seven years, the manufacture of sugar by the open pan process was taken up in the Punjab in 35 new sugar factories most of which were small scale concerns opened in 1932-33. But the Sugar Excise Duty of 1934 and the enhanced Excise Duty of 1937 proved too much for the manufacturers in the Province. Sugar is now a decadent industry in the Punjab. Only three vacuum pan factories worked during 1937-38. This is surprising, because the Punjab constitutes the second largest sugarcane producing area in the country. But sugarcane of the Punjab is said to be unsuitable for the manufacture of sugar. Only 4 per cent. of the cane produced is utilised by vacuum and open pan sugar factories while as much as 70 per cent. is converted into *gur*, 14 per cent. is fed to cattle and 12 per cent. is used for seed and chewing purposes. The Director of Agriculture in his last annual report makes the following interesting observations :—

" Vacuum pan sugar factories have not been established on a large scale in the Punjab. Six such factories which consumed sugarcane, as opposed to *gur* refineries, exist, but only half the number worked during the year. Those which were closed were small in size and it is probable that high overhead charges combined with low sugar extract made it unprofitable to work them. The results obtained by those factories which have been working are said to be less satisfactory than those got by factories in the United Provinces and Bihar. One factory maintained that from sugarcane grown locally, it obtained a sugar extract of only 7·7 per cent. against 10·18 per cent. from cane of exactly similar varieties imported from the United Provinces. *Gur* refineries also do not favour Punjab *gur* and purchase most of their supplies from the United Provinces and Bihar. It is thought that the inferiority of the Punjab cane from a sugar producing point of view is probably connected with the alkalinity of the Punjab soils, but the cause is being explored. The difficulties of disposing of the cane crop which were experienced late in the season this year in the adjoining Provinces did not exist in the Punjab whose cane growers are independent of sugar factories for the disposal of their crop."

Metal and Engineering Industries.

Next to cotton and sugar, the metal and engineering industries have received the greatest attention in the Punjab. During the last decade in 1930 was established Mukand Iron and Steel Roller Mills, Lahore, which started manfacturing mild steel rods, flats, etc., and erected a steel furnace in 1935-36. In 1931-32 Messrs. Raghu Ram Tulsi Ram, Lahore, installed a plant near Badami Bagh for the manufacture of steel bars and flats. Progress in this work was well maintained, and in 1935 cast iron rain-water pipes factory of Messrs. Hume Pipe Manufacturing Company, Lahore, and Indian Fan and Motor Manufacturing Company, Lahore, started operations. In 1936-37 three new steel rolling mills were set up in Lahore, and another two at Amritsar. The Steel and General Mills of Lahore has erected a four-ton electric steel furnace, and the Upper India Metal Works at Chheharta installed machinery for the manufacture of cow and ox-chains. The electric fans produced by the O. K. Fan Company, the Punjab Fan Company, and the Alfa Fan Company of Lahore and Messrs. Mohammad Din & Sons of Amritsar have proved very popular. The Auto-Welding Company of Lahore has successfully supplied acetylene welding plants to the North Western Railway which compared favourably both in quality and price with the imported articles.

In 1931-32 Messrs. Janki Das and Company started the manufacture of perambulators, tricycles, miniature dummy motor-cars operated by paddles, and bicycle saddles, and it is a matter of great credit for them that they have been able to withstand the competition of cheap Japanese articles, and that they have been able to secure a good market for their products.

The Indian Sewing Machine Company of Lahore has also started producing well-made machines.

Glass Factories.

The glass industry suffered from severe competition from Japan in 1932-33, and the Upper India Glass Works, Ambala, were forced to reduce the prices of their articles.

In the same year the Globe Glass Works Amritsar, had to close down owing to the bursting of their furnace. Foreign competition continued to press heavily on the industry, and one of the glass factories at Amritsar stopped work in 1934-35. In December 1934, however, a new glass factory was opened at Qadian which produced lantern chimneys, tumblers and bowls. The industry still needs considerable consolidation before it can claim to be on a sound footing.

Match Industry.

The match industry in the Punjab has been very adversely affected by foreign competition of the Swedish Cartel, and as in the case of sugar, by the imposition of the Match Excise Duty. Two match factories in the Province had to cease working on the 1st April, 1935, for about six months and in adjusting themselves to new conditions, they have been unable to thrive. In 1936-37 the Star Light Match Factory at Gujranwala remained closed for most of the year; the Gujranwala Match Company worked by fits and starts, and the Maha Laxmi Match Factory, Shahdara, did not work for four months.

Other Industries.

Among other industries special mention must be made of the Cement Factory established at Waha near Hasan Abdal, and at Dandot, and the Pulp and Paper Mills at Abdulpur, and of the products such as boot polishes, varnishes, sealing wax, numerous printing inks, of the Jallo Subsidiary Industries Company, and of the coloured pigment and varnishes produced by Ravi Paints Works, Lahore and the Punjab Paint Mart, Lahore. The Cigarette making factories at Lahore and Jullundur have been, on the whole, doing fairly well. The Santanam Gramophone Records Company, Chheharta, has been manufacturing gramophone records under the supervision of German experts since 1936. Mention must also be made of the increasing manufactures of acids, chemicals, tinctures and medicines and of the various rubber works of the Vegetable Oil Milling Industry.

And yet notwithstanding the achievements recorded above, the Province is as yet largely dependent on the outside world for manufactured and finished articles. An industrial survey of the Province has been recently undertaken, and the University Departments of Chemistry and Economics are rendering useful service, but unless a steady and combined drive fully supported by the Government and the intelligentsia is made the future is not particularly hopeful.

CHAPTER V

A SKETCH OF THE GEOLOGY AND MINERAL RESOURCES OF THE PUNJAB

BY

D. N. WADIA.

The Punjab, the Land of Five Rivers, is geologically speaking, of very recent age, much the largest portion of its surface having been built up by the silting action of its principal rivers and their tributaries, during practically the last chapter in the geological history of the earth. North, east and south Punjab is thus a gift of the Himalayas, being chiefly composed of the materials worn from these highlands by the various atmospheric agencies and brought down as silt, sand and other detritus and deposited in a flat trough at their foot. The geological records of this part of the Punjab, whatever they may have been, are thus concealed under this alluvial mantle, which is several thousand feet in thickness and extends horizontally over $\frac{7}{8}$ of the Province. For an account of the geological history of this part of India during the vast cycle of past geological ages we have to turn to the portion of the Punjab west of the Jhelum, wherein are to be found, in the rock-beds of the Potwar (*Puthwar*) plateau and the Salt Range mountains, abundant though fragmentary records of most of the periods in the past history of the earth. Another area where a section of the geologically older rock-systems are displayed is the strip of broken hilly country between Rawalpindi and Ambala, where the Punjab plains adjoin the foot of the Himalayas, known as the Sub-Himalayan zone. These parts of the Punjab have escaped the deep alluviation of the rivers by reason of powerful crustal movements, co-eval with the final uplift of the Himalayas, which folded and elevated them beyond the reach of river action. Piecing together the data available in various parts of the Salt Range, the Potwar terrain and foothills zone, we find the following rock-systems, representative of the principal periods of geological history. These constitute the geological record of the Punjab:—

TABLE OF GEOLOGICAL FORMATIONS OF THE PUNJAB.

	Geological Period.	Salt Range.	Potwar, foothills zone and other areas.
CAINOZOIC	Pleistocene	River-gravels, loess. Spring deposits.	River-terraces, loess, gravel-beds, erratic blocks, travertine, etc.
	Pliocene	Siwalik system of river deposits with mammalian fossils	Siwalik system
	Miocene		Murree series, ferruginous sandstones and shales Dagshai and Kasauli series of Simla area
	Oligocene	—	
	Eocene	*Nummulitic* limestone Rock-salt and gypsum deposits Coal-measures of Dundot and Makarwal	*Nummulitic* limestone series. Subathu series of E. Punjab. (Oil-bearing horizon of the Punjab).
MESOZOIC	Cretaceous	Massive sandstones	Ginmal series of Kala Chitta hills.
	Jurassic	Limestones and variegated shales and sandstones	Kioto limestone of Kala Chitta.
	Triassic	*Ceratite* limestone	Trias of Kala Chitta hills
PALAEOZOIC	Permian	Richly fossiliferous *Productus* limestone	Missing in Potwar Krol series of Simla
	Carboniferous	Speckled sandstone Glacial conglomerate	Missing in Potwar. Blaini series of Simla.
	Devonian	Missing	Missing
	Silurian		
	Cambrian	Magnesian sandstone *Neobolus* shales Purple sandstone	Delhi system } of Delhi and the Kirana and Sangla hills.
	Pre-Cambrian	—	Aravalli system

From the above table it will be seen that except for the Cainozoic, or Tertiary rocks, which cover almost the whole terrain between the Jhelum and Indus, and are very fully developed in all their stages, the remaining section of the geological record is imperfectly preserved over the greater part of the area of the Province. However, the Salt Range mountains make ample amends for this defect by presenting within a narrow compass a unique portion of the geologic column such as is rarely seen in other parts of India. These mountains form a continuous range of low, flat-topped escarpments, rising abruptly out of the flat plains of the Jhelum, extending for about 100 miles from Longitude 71° E to 74° with an irregular curving strike, approximately E—W in the main. Besides presenting a fairly full stratigraphic sequence from early Palæozoic to the end of the Cainozoic, these mountains exhibit striking structural and physiographic phenomena. The prominent structural peculiarity of the Salt Range is the more or less level plateau top, ending abruptly to the south, and a gentle inclination to the north, merging into the Potwar plateau, which is a structural basin or trough between the Salt Range and the Rawalpindi foothills, filled up by Tertiary deposits. The general dip of the strata is to the north from one end of the range to the other. Thus it is on the north border that the youngest Tertiaries are seen while in the steep southern scarp-face the oldest palæozoic beds are exposed, succeeded higher up by the Mesozoic and Tertiary. The entire length of the range is traversed by a series of transverse fault-fractures, while at its foot are observed planes of sheer or thrust along which the whole range has been thrust bodily southward by pressures acting from the north.

There are in the Punjab two most important rock-formations whose stratified sequence and contained fossils have contributed much to elucidate the geology of India and yielded valuable material to palæontologists. One of these formations is the Productus Limestone in which is entombed a varied fossil fauna of marine molluscs, brachiopods, echinoderms, corals, etc., belonging to a period when eastern India was covered under a dense forest vegetation, the carbonised remains of which are found to-day in the coal-fields of Bihar. The other notable Punjab formation is the Siwalik system of sandstones and clays, in which are preserved fossil remains of mammals of an age very near to our own, the ancestors of our living cattle, horses, elephants, camel, primates and carnivores. The specific and generic variety and richness of the Siwalik mammals shows that northern India during the Mio-Pliocene epoch was a great centre of evolution of the higher land life, in comparison with which our living mammals are few and small.

It is probable that rocks older in age than the Cambrian lie buried under the alluvial country south of the Salt Range in linear ridges which may be regarded as northward and N-W'ard prolongations of the Aravalli Range of Rajputana, the most ancient mountain-chain of India. One such hidden ridge shows itself at the surface in the small hillocks of Kirana and Sangla, which may be regarded as the unsubmerged peaks of the ridge and another strikes northward from Delhi towards Saharanpur. Around Delhi there occurs a good development of these ancient rocks (the Delhi system) at the surface, the famous Ridge of Delhi being composed of quartzites belonging to this system.

In the Sub-Himalayan foothill zone, the rock-formations laid bare are mostly of Upper Tertiary age, thrown into a series of simple folds, which constitute the low ranges of sorely denuded hills, known as the Siwalik hills. Beyond this, to the north we come across a belt of country occupied by older strata of Murree age (Kasauli and Dagshai series) in the deeper plications of which are laid bare strips of still older Eocene rocks composed of *Nummulitic* limestone (Subathu series). Beyond these, in the mountains of Solon and Simla, a complicated type of mountain structure prevails, which has wrinkled, sheared and thrust forward the older Himalayan rock-systems (*e. g.*, the Krol, Blaini and the much older pre-Cambrian) on to the newer Tertiary, along low planes of dislocation and thrust over a horizontal distance of several miles.

The alluvial country of the southern Punjab gradually passes into the desert tract of Rajputana (the *Thar*) by the long continued aridity and desiccation of this region and through the inroads of wind-blown sand, brought from the south by the prevailing south-west monsoon gales, which blow for 5 or 6 months of the year across the region without precipitating their contained moisture. The desert conditions have been of comparatively late growth, for about 2000 years ago this part of western India appears, from several historical as well as physical evidences, to have been a well-watered and fertile area.

The present watershed of North India, dividing the drainage of the east, *i. e.*, of the Ganges system, from that of the west, *i. e.*, the Indus system, lies in the tract of alluvial country between Saharanpur, Ambala and Ludhiana. There exists much evidence to prove that this was not the old water-parting. The courses of most of the rivers of the Punjab have undergone considerable oscillations, and even radical alterations. The Indus itself, during the Pleistocene period, is believed to have been originally confluent with the Ganges when that river flowed from Assam into the Sind Gulf by a channel that is now occupied by the small stream of the Soan river of Rawalpindi. "The river Jumna, the sacred Saraswati of the Hindu Shastras, in Vedic times flowed to the sea through eastern Punjab and Rajputana, by a channel that is now occupied by an insignificant stream which loses itself in the sands of the Bikaner desert. In course of time, the Saraswati took a more and more easterly course and ultimately merged into the Ganges at Prayag. It then received the name Jumna. Most of the great Punjab rivers have frequently shifted their channels In the time of Akbar, the Chenab and Jhelum joined the Indus at Uch, instead of at Mithankot, 60 miles downstream, as at present. Multan was then situated on the Ravi, now it is 36 miles from the confluence of that river with the Chenab. 150 years ago the Beas deserted its old bed, which can still be recognised between Montgomery and Multan, and joined up with the Sutlej near Ferozepore, several hundred miles upstream. An old river bed, the Hakra, Sotra, or Wahind more than 600 miles in length, the channel of a lost river, is traceable from near Hoshiarpur at the foot of the Himalayas, through Bhatinda, Bikaner and Bhawalpur to Sind. It is probably the old bed of the Saraswati (the Jumna when it was an affluent of the Indus) at a time when the Sutlej and Beas flowed independently into the Indus beyond Multan." (Wadia: Geology of India, p. 285, Macmillan 1938.)

Mineral Resources of the Punjab.

(Economically Useful Mineral and Rock Deposits)

The Province of Punjab must be regarded as poor in economic rock and mineral deposits. Its chief asset lies in the agricultural wealth of its soil-cap. The mineral the Province has got in great abundance and in accessible and easily utilisable state is water, water from the high snow-fields and perennial springs of the Himalayas, which can be put to a number of engineering, hydro-electric, agricultural and industrial uses. The useful products which the rocks and minerals of different parts of the Punjab yield may best be considered under the following heads:—

Water
Building stones
Lime, cement
Sands and clays
Fuel, coal, petroleum
Ores
Rock-salt
Gypsum
Alum
Reh, usar, etc.

Water

Underground water exists in abundant quantity in most parts of the vast alluvial tracts of the Province and can be tapped easily by ordinary bore-holes The plains of the eastern Punjab may be regarded as an underground reservoir of fresh sweet water, but the area of the north and north-west as well as the desert tracts of the south-west with their relatively small rainfall and deeper water-table, 100 to 300 feet below the ground surface, have very deficient underground supplies of water and at places present an acute problem. For these arid areas where ordinary wells do not function in the drier seasons, tube-wells of 2-4 inch diameter and over 300 feet depth alone can be expected to reach a perennial source of potable water.

Thermal and Mineral Springs. Such springs are common in the Salt Range, Rawalpindi and Kangra districts. Saline springs are numerous in the former area, while sulphurous, calcareous and chalybeate (ferruginous) springs are widely scattered in the latter districts, over outcrops of the Nummulitic series and its related group of rocks. A few of these springs have a temperature appreciably higher than that of the surrounding air. The famous Jwalamukhi springs of Kangra, *e.g*, those at Lausa, Tatwani, Tiwa, Jwala, etc., have been long known for their theraputic properties in goitre. They contain about 25 parts of salt (sodium chloride) in 1000 parts of water, with a trace of iodine; their temperature varies from 70° to 120°F. The thermal springs of Manikaran and Sitakund in Kulu are sulphurous, with a temperature varying in the different springs from 110° to 202°F

BUILDING STONES

Rocks when easily dressable and of good durability, colour and texture are quarried for use as building material for important public and private structures. Stones of excellent quality suitable for such use are obtainable in unlimited amount from the Salt Range and in lesser quantities from the Kala Chitta and Margala hills, near Rawalpindi. Since no building stones of sufficient durability or pleasing aspect are obtainable for hundreds of square miles of the Punjab this source must be regarded as of high potential value to the Province. Three geological formations of these parts furnish the requisite quality stones— the purple sandstone and magnesian sandstone (a cream-coloured dolomitic rock) of the Cambrian system; the Nummulitic limestone, of white, buff and grey tints; and the Productus limestone which at places yields pink, grey and black flags and blocks capable of taking a high polish.

In the Narnaul district of Patiala, black limestones well suited for building and lime manufacture, have been in use, while black and white marble, banded marble have been rather extensively quarried in the past.

Other formations supply, when properly selected, good building material and road metal, *e. g.*, Murree and Siwalik sandstones, travertine, etc.

Slates, when sufficiently fissile, are used as tiles, flags, or slabs and support a considerable industry in some countries. In the Punjab there are only two localities which supply good quality slates—the Kangra quarries on southern flank of the Dhauladhar range and the quarries of Rewari in Gurgaon district. Large reserves of raw material exist at both the localities and with improved method of dressing and marketing, the industry has a good future. The Attock slate in the north-west is easily accessible and has large supplies, but the slate is too irregularly cleaved and jointed to yield tiles or slabs of any size. Kankar, the irregularly disseminated calcareous concretions in the alluvial clays, furnishes a valuable and much-needed road-building material in all parts of the Punjab where stones are scarce.

LIME AND CEMENT

Lime for mortar-making is obtained by burning any of the limestones commonly occurring in the Province, though some are of greater value than others. Kankar is a widespread and readily available source in the plains tract. Travertine, or calc-tufa, is found extensively in the Salt Range and parts of the Rawalpindi plateau, remains of deposits left by extinct springs. The clay content of kankar imparts to the burnt lime some hydraulic property for which it is sometimes more valued than pure lime.

The Punjab may be regarded as rich in resources for cement manufacture. Unlimited supply of raw materials exist in the pure limestone deposits of the Salt Range, Margala hills and Kala Chitta hills and in the beds of clay interstratified with the Middle and Upper Siwaliks of contiguous localities. The Subathu and Krol limestones of the eastern Punjab are also a large potential source.

SANDS

Pure quartz sand free from all iron impurities, and possessing a uniform grain and texture, is of economic value in the manufacture of glass Such sands occur only in the Hoshiarpur district (Jaijon Doaba). A subordinate source of sand of the requisite quality may be found in some of the white granular sandstones occurring in the Salt Range at the base of the Productus limestone series (Talchir beds) in the eastern Salt Range. Crushed quartz has also been put to use, as at Ambala, for manufacture of glass of good quality.

CLAYS

Varieties of clay which are of considerable industrial application, such as china clay, for manufacture of better grade porcelain; terra cotta clay, for use in the making of unglazed large-size pottery, are of rather scanty occurrence in the Punjab. Fire-clay, from which most of the iron and alkaline salts have been removed and thus fit for use in the making of fire-bricks and refractories, has been found in association with the Dandot coal-seams at one or two localities in the Eastern Salt Range, in restricted quantities. Other localities in the adjacent coalmeasures of the area need further prospecting. Fuller's earth, a clay with a high absorbent power for water or oil and its variety bentonite (with considerably greater absorptive power), of use in several modern industries, have so far not been found in notable amounts in the Province. "Multani mittee," a clay occurring at the base of the Eocene rock of the Punjab and Rajputana, is a variety of fuller's earth and is marketed in some amounts. An abundant source of clay for rough pottery, as raw material for cement manufacture, brick and tile-making exists in some of the finer alluvial clays of the plains and in the Middle and Upper Siwalik series of the foothills.

The extent of the economic utility and value of clay in the industrial world of to-day may be judged from the fact that in the United States of America the annual values of clays produced for various manufactures amounts to £ 72,000,000.

FUELS

The chief mineral fuels, coal and petroleum, occur in association with the Tertiary rock-system of the Punjab :—

COAL

The Eocene rocks of western Punjab contain two coal measures, one in the eastern Salt Range at Dandot and the other at Makarwal in the trans-Indus extension of that Range. Though possessing rather limited total reserves of coal, distributed in a few thin seams, and the quality of the fuel is distinctly second rate, the Punjab coal deposits are of value to the local industries because of the high transport price that has to be paid for importing coal from the nearest Gondwana coal-fields of Bihar, 800 miles away. The total amount produced to-day from the two fields has increased to 140,000 tons per annum from 43,000 tons per annum barely 10 years ago. Coal mining in the Punjab suffers from several handicaps; the seams are generally thin, 2 to 3 feet thick on the average, a circumstance which renders extraction difficult ; the coal, properly speaking a lignite, is friable with a high ash-content, generally between 15 and 25%; another serious drawback is the injurious proportion of sulphur which makes the coal liable to disintegration, and even to spontaneous combustion, on exposure. With modern methods of improving the fuel mined, by mechanical treatment, and by its use in the furnaces in the form of pulverised coal, some of the above disabilities can be got over

PETROLEUM

Associated with the Eocene rocks of the Punjab is also a petroliferous horizon, which though it has given rise to a number of petroleum shows and seepages in the Salt Range and parts of Attock, Rawalpindi and Mianwali has yielded oil in commercial quanitity only at one locality. The oil wells of the Attock Oil Company are drilled on the crests of two dome-like folds at Khaur and Dhulian, near Pindigheb in the Potwar The Khaur and Dhulian oil-fields, discovered by the Company after long and laborious geological investigation, have, since 1914, produced over 3,000,000 barrels of oil. With increasing depth (some of the wells are as much as 7500 feet deep) and patchy distribution of the oil in the sands capping the mother-rock, drilling is a matter of considerable technical difficulty and expense. The present yield, 4·5 million gallons per annum, shows a recovery after a serious fall in production since the year 1929, when more than 19 millions gallons used to be the annual production. Of the numerous oil springs and seepages the best known occur in Rawalpindi, Mianwali, Attock and Shahpur districts.

Energetic prospecting by geologists is still in progress in the Punjab and since suitable structural conditions in the Lower Tertiaries which are likely to serve as underground reservoirs or chambers for oil, are known in several parts of these districts, the discovery of further deposits of this important mineral is not beyond the realms of possibility.

Some deposits of oil-shale, which is capable of yielding oil in distillation, have been discovered of late years. However, the known occurrences are of a size which seem to possess no economic value.

ORES

The Punjab is definitely poor in metalliferous deposits of economic value. Such basic metals as iron, copper, tin, lead and zinc are either unknown altogether, or occur in their compounds in quantities too insignificant to be fit for economic exploitation.

Gold The sands of the Indus have been known to be auriferous since days of antiquity and Kalabagh, Attock and the point of junction of the Soan with the Indus have been carrying on gold washing of the sands for many centuries. The gold won, however, is trifling in amount, barely enough to give the day's wage to the families (*Sonaras*) engaged in the work. The original source of the gold is believed to lie in the crystalline rocks of Ladakh and beyond, at the headwaters of the Indus.

To a less extent gold-washing is practised in the Sutlej and in the Gomti tributary of the Markanda river. In 1914 about 250 ozs. of gold were produced in the Punjab, but the present figure is considerably less.

Iron Ores. Oxides of iron, hæmatite and magnetite, occur in some quantity in Sirmur, Kulu and Kangra areas of the east Punjab, but the distance of the deposits from existing sources of fuel and fluxes render their economic working impossible.

Iron Pyrites. This ore, sulphide of iron, is put to use as a source of sulphur in the manufacture of sulphuric acid. The occurrence of this mineral is fairly widespread in the form of small disseminated particles and nodules in the Eocene shales associated with the coal-measures. It is, however, not concentrated enough to be of economic interest and even constitutes a harmful ingredient in the Punjab coal, reducing its utility in the furnace.

Galena. Sulphide of lead has been known in the older rocks in strings, veins and lodes in the Parbati valley of Kangra and in the Subathu area. The lead ore is often argentiferous, containing from 15 to 50 ozs of silver to the ton. The deposits, however, have so far not attracted the serious attention of prospectors.

ROCK SALT

Since the days of Ranjit Singh the rock-salt mines of Khewra, Jhelum District, and other parts of the Salt Range have been the centre of the most important mining industry in the Punjab, though salt was extracted from these areas for several centuries before that date. The rock-salt deposits of the Salt Range occur at the base of the Eocene system of rocks and constitute an immense source of pure crystalline sodium chloride. At Khewra two beds of salt, 550 feet thick, are interstratified with a red marly clay and gypsum; they contain five seams of almost chemically pure salt, totalling 275 feet, intercalated with but few earthy layers unfit for direct human consumption. The horizontal extent of these beds is not definitely known, but it is thought to be over several square miles Smaller mines are worked at Warcha and Kalabagh on the Indus

Salt deposits of considerable magnitude are also known in the Tertiary deposits of the Mandi State. The total annual production of rock-salt in the Punjab of recent years is about 170,000 tons: the reserves of salt are, however, sufficiently large and the production is capable of being extended to meet a far larger demand, but the supply of cheaper and more economically distributed salt, manufactured from sea-water at more favourably situated localities does not offer any immediate prospects for the expansion of the Punjab rock-salt industry.

Potash Salt, of value in agriculture and chemical industries, have been found in association with the rock-salt deposits of the Mayo Mines at Khewra. The amount of potash content varies from 7 to 14 per cent. and the total quantity available from this site is about 3,000 tons.

Saltpetre, which used to be produced to the tune of a few thousand tons annually in the Punjab mostly for export is no longer a remunerative industry in face of the chemically manufactured product.

GYPSUM

Associated with the rock-salt deposits of the Salt Range and Mandi State there occur large masses of pure white or light grey gypsum, the total quantity of this mineral available being of the order of several hundred million tons. The gypsum occurs in beds up to 50 lb. feet thick, in cliff sections well exposed at the surface, and offering but little difficulty of extraction The chief industrial application of gypsum is in burning it for the manufacture of plaster of paris. There are several other minor uses. It is also used as a surface dressing for fields in agriculture with considerable benefit to certain crops

The demand for gypsum in Punjab is very limited as is indicated by the low price the mineral fetches, sometimes as low as Re. 1 for 15 cwt.

ALUM

In days before the chemical manufacture of alum and its cheap importation from foreign countries, the industry for making alums out of the pyritous shales of the Eocene series at Dandot and Kalabagh, was one of considerable proportion and over a ton of alums of different composition used to be produced some 70 or 80 years ago The quality of alum produced at these centres, mostly soda and potash alums, was regarded as very good, but the industry to-day has declined, if not almost died out, as very little production on a commercial scale is reported.

Ochre and Paint Materials. Red and yellow ochreous earths impure earthy hæmatite or limonite, deeply coloured or black shales and slates, gypsum, etc., when of suitable consistency and fineness are used in the manufacture of paints The occurrence of some of these substances in the Salt Range area is known from a few localities but the substances are not so far utilised for manufacturing purposes.

A large quantity of yellow ochre is found in a sub-recent deposit in the Ratang river, Kangra district

REH OR KALLAR

This is the name of the saline efflorescence, composed of a mixture of sodium carbonate, sulphate and chloride, together with varying proportion of calcium and magnesium salts, found on the surface of alluvial soils, in the drier districts of the Province. *Reh* is not an economic product and its description here is included because of its negative quality as such. The soil of some parts of the Punjab is so impregnated with these salts that they are rendered quite unfit for tillage. Large tracts of once fertile and populous districts have, through its agency, been thrown out of cultivation and made sterile. The cause of the impregnation of the salts in the soil and sub-soil appears to be this: The rivers draining the mountains carry with them a certain proportion of chemically dissolved matter, besides that held in mechanical suspension, in their waters The salts so carried are chiefly the carbonates of calcium and magnesium and their sulphates, together with some quantity of sodium chloride, etc. In the plain track of the rivers, these salts find their way, by percolation into the sub-soil, saturating it upto a certain level. In many parts of the hot alluvial plains, which have no underground drainage of water, the salts go on accumulating and in course of time become concentrated, forming new combinations by interaction between previously existing salts. Rain water percolating downwards dissolves the more soluble of these salts and brings them back to the surface during the summer months by capillary action, where they form a white efflorescent crust.

The reclaiming of these barren *kallar* or *usar* lands into cultivable soils by the removal of these salts would add millions of acres to the agriculturally productive area of India and bring back under cultivation what are now altogether desolate uninhabited areas.

The carbonate and sulphate of soda, the chief constituents of *Reh*, at some places have reached a degree of concentration to be commercially exploitable in large amounts. These salts were formerly used in the industry as a source of alkaline salts, but their production now is no longer remunerative.

CHAPTER VI

ARCHÆOLOGY IN THE PUNJAB

BY

C. L. FABRI, PH.D., D.LIT., FIELD DIRECTOR,
PUNJAB EXPLORATION FUND.

When writing of "archæology in the Punjab," we must make it clear that we are not writing of "ancient monuments in the Punjab.' For the latter may be as rich and numerous as anywhere else in India; but the former, archæological research, has revealed as yet extremely little. With a little exaggeration which is permissible when making a broad generalisation, one may well say that archæology in the Punjab consists so far in two important and imposing names: Harappa and Taxila. At these two places serious and extensive excavation work has been carried out through a number of years, and the results are of far reaching importance, both being typical " key-sites," to the stratification and chronology of which other sites are bound to attach the greatest weight. I think I am accurate when I say that Taxila has been excavated for a longer time than any other site in India, Mohenjodaro not excluded: for *systematic* work alone lasted well over twenty years at that place. Harappa too has been attacked practically every year since 1921: though the work there was neither so extensive, nor so satisfactory as at Taxila.

Besides these two sites several other places have been " scratched "with more or less success. I am fully conscious of the implication of the word "scratched." The fact is simply this that (barring Taxila and Harappa) practically nothing worth mentioning has been done in this vast and magnificent Province that must have played ever since he Dawn of History a most important role in the evoution of human culture in general, and India in particular. There are hardly any Buddhist monuments known in the Province, though, as will be seen below, there are excelent indications where such monuments may be found, s in the case of isolated but important finds in the Kangra District, where local research would undoubtedly reveal ome of the fifty monasteries mentioned by the Chinese pilgrim, HIUAN-TSIANG. Traces of Stone Age will be found mentioned below: clues that future generations of archæologists may profitably follow up. Hindu monuments do not abound either, with the exception of Kangra again, where, too, very little has been done so far to penetrate deeper into the problem.

It is impossible in such an account of "archæology in the Punjab" not to deplore the neglected state of antiquarian research in the Province. This Province of the Five Rivers, mentioned in the earliest Sacred Writings of the Hindus, known to have formed part of Asoka's Empire and to have played an important role ever since, is literally scarred with ancient mounds, many of which have never yet been visited by an antiquarian. In the past two years, when the writer of these lines was in charge of the re-arrangement of the Central Museum, Lahore, he made occasional week-end excursions into the neighbourhood: and in the course of such reconnaissances he discovered no less than seventeen ancient mounds, situated inside a radius of some fifty miles from Lahore Town. This is a good indication of hundreds of old sites that could be found all over the Province, and of which I received my first glimpse when accompanying SIR AUREL STEIN in his explorations in 1931. No day passed without our visiting two to five mounds along the old bed of the Beas and elsewhere.

This is exactly what one should expect. In a country as fertile and pleasant as the Punjab, people have always lived; and it is impossible to imagine that generation after generation lived here, disappearing without leaving some trace or the other behind them. To every thinking person it must be evident that the Archæological Survey of India, which is in charge of this vast continent, cannot possibly be expected to do more than it is doing now. Full credit is due to the Department for the fine pioneer work so far done. There is no country in the world to my knowledge where archæology is entirely run by Government. The greatest explorations have always been done by private enterprise and due to the generosity of munificent donors. What is, thus, needed is more interest on the part of the intelligent public, and more popular lectures and exhibitions organized by the expert. It is the expert's fault if the general public does not know of his researches, for it is his duty to go and tell the world what he has found. The regrettable ignorance of the larger public about Indian archæology in this country is, probably, partly due to the fact that all archæology was done so far by hard-worked Government servants, officers of the Archæological Department, who had, anyhow, their hands full of constructive work and could not easily spare time for popular lectures. Yet the time had come to realize how disastrous the continuation of such a method would be. Like a vicious circle, it will hit the Department itself; for lack of interest will result in the reduction of grants and the lack of gifted recruits. In the present Director General we have, fortunately, a scholar who realizes the importance of public opinion, and takes due interest in publicity.

The Punjab Exploration Fund, the first Provincial Exploration Fund so far founded in India, tackles the problem from a similar angle; and the interest it has roused so far shows that such a movement will bear good fruit.

The Stone Age.

Palæolithic and neolithic implements as well as microliths of unknown age have been found in the Salt Range. In 1935 DR. HELLMUTH DE TERRA, the German-American geologist, discovered under a deposit of palæolithic implements an ancient interment ground near Chitta, over a layer of pleistocene marl, in a loess-like secondary silt.

These results have not yet been properly checked, and are well worth following up.

Harappa, in the district of Montgomery, can properly be described as a provincal town of considerable size, the flourishing period of which was at the very end of the Neolithic Period, with a scarce but gradually increasing use of the first non-precious metal, copper. This date roughly corresponds to about 2000 to 2300 B. C., hence it is præ-Aryan, and the town might well have been one of the ***Puras*** of the ***dasyus*** mentioned in the ***Rigveda***.* There is no proper publication as yet of the discoveries at this place, though Pandit M. S. VATS has been preparing a large-sized publication for several years past. It is sincerely hoped that this *magnum opus* of his will soon see light. Accounts of the yearly work done are found in the *Annual Reports of the Archaeological Survey.*

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* The author regrets that no diacritic marks were available for the printing of this article.

Clear distinction must be made at Harappa of the city proper on the one hand, and the cemetery on the other. The funereal ceramic ware, as everywhere else in the world, shows conservatism, and represents an earlier phase of ceramic decoration preserved for religious purposes, whereas the fashion among the living underwent a change But apart from these and other minor differences, the essence of this culture is that the people, the first time in the history of mankind—here as in Mesopotamia, Egypt and China—at this period started living in well-ordered cities. developed to an amazing standard the art of the potter (on the wheel); gradually discarded stone implements for copper ones; developed primitive pictographic symbols into a connected script, so far undeciphered; knew glass and glazed ware; made faience bangles and other objects; used wheeled carts; buried their dead in various fashions; worshipped a horned deity and divinities in the tree; had a legend about the Hero and the Lions; traded with many other countries whence they imported raw materials and the like: and were particularly able engineers as far as drainage was concerned. Their women wore ornaments of gold and silver and copper and clay; and they applied antimony to their eyes. Cotton was known to them. The men, though probably mainly agriculturists and traders, carried weapons about them, and could handle a fishing hook or a net. They had razors and shaved.

Their houses were singularly simple burnt brick buildings, unless mural paintings have originally decorated their walls, of which the writer of these lines has some evidence. More carefully conducted excavations in future may well reveal such mural decorations. The most wonderful, however, from an artistic point of view, are the magnificently carved stone seals (negatives); of which several thousands have been unearthed (Plate I, Fig. 1.) and the two astounding little figurines, one of a fine-bodied, almost athletic man, and the other of a dancing girl (?), so beautifully carved that many people

Plate I

Archæology in the Panjab

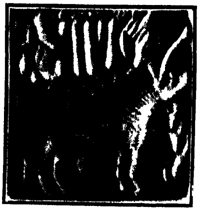


FIG. 1

Steatite seal from Harappa of the "Unicorn" type with a figure of a "Devil Dancer" (?) before the beast, and an undeciphered inscription on top. Size c. 3 cm sq.

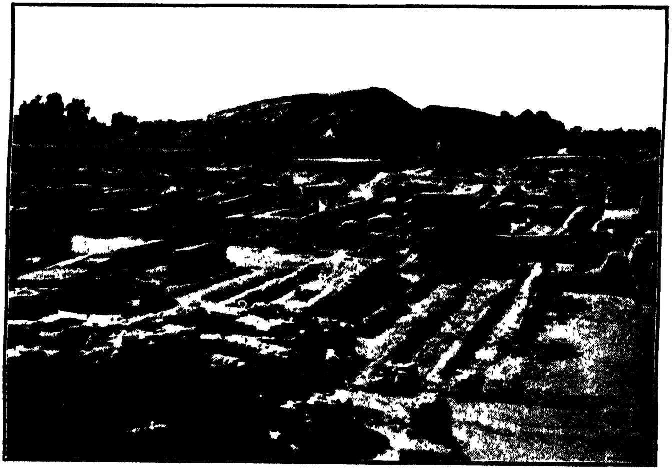


FIG. 2.

Part of the excavated area in Harappa, showing the "Area of the Parallel Walls" probably granaries; with unexcavated mounds in the background.
(*Photo by* DR. R. MACLAGAN GORRIE)

could not at first believe the existence of such masterpieces at such an early date. Yet there can be no doubt at all that they belong to the same period as the carved seals.

The ceramic ware itself testifies to high artistic skill and excellent taste. At a time when pottery was the main medium in which the love for the beautiful could express itself, the potter lavished much skill upon the decoration and shaping of his vessels. Monochrome and polychrome painted ware to the tune of some ten thousand has been unearthed at Harappa, and few, if any, have entirely identical decoration; though some favourite patterns recur very often. Everything points to the fact that the main period at Harappa was somewhat later than that at Mohenjodaro in Sind, the other great site of this cultural type. Definite evidence of connexion with Western Asia, particularly with Elam and Iran and even Crete, shows that the trade routes between the great civilizations of the time were regularly frequented by trading caravans.

Harappa has not been fully excavated by any means, (Plate I, Fig. 2). On a conservative estimate, there may be about ten times as much work left as already done. It is very much hoped that further excavation work at that large site will be carried out with great circumspection, and somewhat more systematically than hitherto; for a visitor to the site is struck by the irregularity with which various portions, apparently without cogent reason, have been attacked and left uncompleted. No doubt, the novelty of a prehistoric site of this type was one of the reasons that the excavators wished to get a general impression of the nature of the site by digging now here, now there. But the time has now come to decide on a regular basis, which stratum and side to attack next; and a strict observation of strata can only be done if the mounds are *sliced* horizontally from the top layer downwards over the entire area, or for considerable portions at least. Particular attention should be paid in future digging operations to the surfaces of walls, so as not to destroy any possible mural decorations.

The Plains of Taksasila.

Taxila, some 23 miles from Rawalpindi, is really a portmanteau name for a truly impressive group of monuments, including three successive town-sites of Taksasila, and Buddhistic monastic establishments in the neighbourhood extending over an area of some 20 miles. The three successive towns, Bhir, Sirkap and Sirsukh, are Taxila proper, ranging from at least the Mauryan period, probably earlier, to well into the 6th century if not the 7th A. D.; whereas all along the low downs, mostly somewhat raised above the din of the cities, were monasteries of the Buddhists, some of them showing signs of fortification, probably in some connexion with the Hun persecutions.

Sir John Marshall's systematic work at that place deserves unstinted praise; for nowhere during his eventful tenure of office as Director General of Archæology in India did he carry out more thorough, more persistent, more accurate work than at Taxila We all know that it was for him a labour of love; and all lovers of Indian antiquities await eagerly his great book, probably in several volumes, on his many years of work at Taxila, which he has been writing ever since his retirement. Meanwhile we possess in his small *Guide to Taxila* a veritable example of what such a guide ought to be, and readers are referred for more detailed information to that little volume.

That the Bhir Mound, the oldest of these various sites, yielded coins of Alexander the Great, is no surprise, for we knew that the Macedonian king, during his short-lived and unhappily ended visit to India, which resulted in the practical annihilation of his army and no territorial gains, visited this town and was received with honours. We also knew that Taxila was famous as a kind of university, or, perhaps more accurately, a school of theology and of medicine—as we did not know of any other faculty. The numerous Buddhistic establishments in the neighbourhood were, no doubt, the residences of the great teachers to whom people from all parts of India flocked,—even from that Greater India that included Ceylon, Siam, Indo-China, Java and China. A thousand years at least were, thus, the life-time of this great and interesting capital of the Gandhara country, inhabited by adventurers and traders, monks and merchants, travellers and soldiers. There were among them Indians and Iranians, Huns and Parthians, Greeks and Bactrians, and many other races of mankind; but most of them, if not all, were united, it appears, by one single bond; they became Buddhists. For though there are a few traces of other religions in the towns, these are insignificant in comparison with the vigorous Buddhistic element.

It is not my intention to give a detailed account of the remains at Taxila, for that can be found in that easily accessible *Guide* to which I already referred the reader. But so much I must mention that Taxila and the surrounding monasteries abound in works of art of a high order. Many of the sculptures, especially those in grey schist, are of a hybrid Græco-Romano-Hellenistico-Buddhistic character, and not often successful; they range mainly from the last decades of the præ-Christian period to about the 4th century A. D. By that time the quality improves considerably, and some of the finest works in schist may confidently be dated to the period during which the whole of India revelled in masterpieces, *i. e.*, the Gupta period. The most attractive works of art, however, date from the 5th and 6th centuries. These are the sculptures made in stucco and originally painted in vivid colours, some of which remain in traces on the original objects. (Plate II, Fig. 1). Here, at this late period, the artist found an expression to a romanticism that followed the classical feeling of the previous two centuries; an Indian baroque of charm and ingenuity, in which the unusual takes the place of the dignified; attractive charm replaces noble elegance; vigorous movement is put instead of restrained canonic poses.

The wealth of this baroque period is reflected also in the exuberance of the jewellery found at that place: one of the attractions to visitors to the local Museum. Metal workers, as well as sculptors, excelled in skill and good taste to satisfy well-to-do customers coming from all parts of the world.

Such is the short account I can give here of the rich harvest made at Taxila; and though much work still remains for the excavator's spade, it can truly be said that there is no site in India where excavations have yielded more satisfactory material than at the ancient site of Taksasila.

Ancient Remains in Kangra.

The largest number of antiquities so far known in the Punjab, besides the plains of Taksasila, are found in what is now the District of Kangra the ancient *Trigarta* and/or *Jalandhara.* Even here, it must be immediately added, very little systematic work has been done so far and even such clues as are loudly crying for being followed up, have been left for future scholars.

The most outstanding example of this kind is the fact that two important inscriptions, discovered two generations ago, pointedly mark towards a direction in which further research is indicated. One of these inscriptions comes from *Kaniara*, on the Chauran river, some 4 miles from Dharamsala, and has been properly edited by Professer J. PH. VOGEL, PH. D., C.I.E., formerly of the Archæological Survey of India, now President, Kern Institute, Leyden University, in *Ep. Ind.*, VII, pp. 116 ff. It dates from the 2nd century A. D. and mentions the foundation of an *arama*, a monastery, by a Krsnayasa, and is written in both Brahmi and Kharoshthi characters. The other inscription comes from *Pathiar*, some 9 miles from Kaniara, on the Buner rivulet, edited also by Dr. VOGEL, *ibidem*; this one records, again both in Brahmi and Kharoshthi scripts, the foundation of a tank by a Vayula,—a name curiously reminiscent of foreign names ending in –*la,* like Kujula, Wulfila. These clues would well deserve to be followed up properly by local research.

Further Buddhist remains have been found at two places in the district, both in the neighbourhood of Nagarkot. Ruins of a large *stupa* have been discovered at *Chetru*, 5 miles from Nagarkot, at the confluence of the Manji and Gurlu *nalas.* The circumference of this stupa is given as 830 feet, and the *Annual Progress Rep., Punjab and U. P.*, 1904-5 and 1905-6, where these finds are reported, chronicles the find of a Buddha image and a detached Buddha head which are supposed to be deposited in the Lahore Museum. I can find no trace of them.

The other Buddhist site is situated 8 miles east of Nagarkot, near *Chari,* where the basement of a stone-built temple (?) has been discovered (CUNNINGHAM,

Archæology in the Panjab.

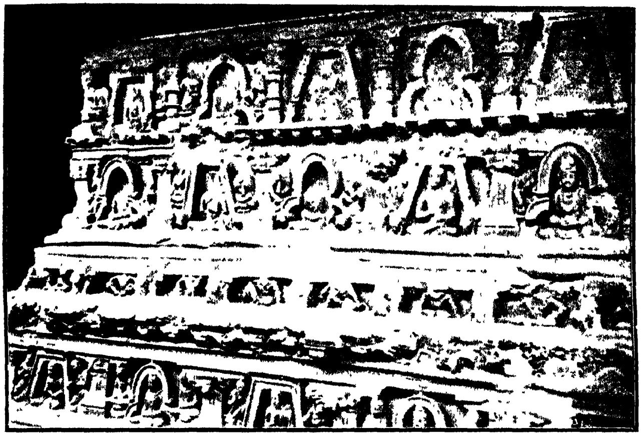


FIG. 1

From Taxila : Sculptured basement of a Stucco Stupa at Jaulian of the late period about 6th Century A. D., with Buddha and Bodhisattva figures in various poses, corinthian, mixed, and persepolitan capitals, elephants and atlantes.
(Photo by C. L. FABRI)

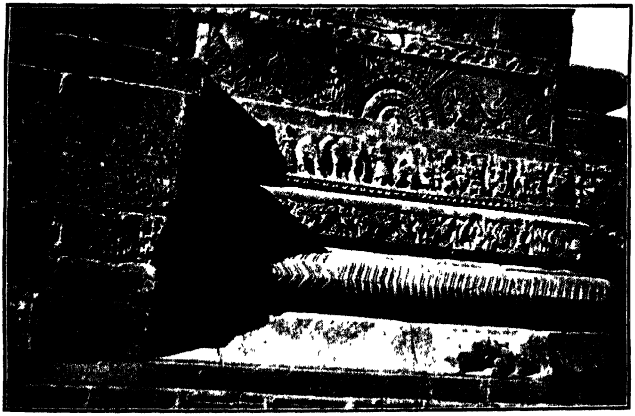


FIG 2.

From Kangra : Portion of the wall of the Nurpur Fort temple built in the "Akbar" style, of Hindu-Islamic hybrid character; with uncompleted portions clearly showing on left and elsewhere.
(Photo by C. L. FABRI)

A.S.R., Vol. V, p. 177), alongside with an inscribed pedestal, from which the image itself was missing. The inscription in characters of the 5th-6th century A. D. proves that the image on it must have been that of the Goddess Vajravarahi. This pedestal, too, has disappeared.

It will be readily understood that the neighbourhood of Nagarkot would be well worth a thorough examination. A site where a Buddha image and a detached head of the Buddha had been found is extremely likely to yield further antiquarian remains.

One of the important objects in the Central Museum, Lahore, is an inlaid brass statuette of the Buddha, with an interesting inscription, that I have copied and translated in the label hung next to the image. This inscription dates from the 6th century, and the figure was purchased from the *dharmsala* at Fatehpur, Nurpur Tahsil. The Visnu image in bronze next to it comes from the same locality and can confidently be dated as slightly younger than the Buddha statuette.

When visiting Kangra last December I had an opportunity to go round the Temple of *Jvalamukhi*, the whole structure of which appears to be nowhere older than the 19th century. But in one of the miniature shrines higher up the hill path I discovered a brass statuette of the Buddha, worshipped by the ignorant priest as the image of the child Krsna. but undoubtedly dating back to the same period if not somewhat earlier than the Lahore Museum brass statuette. Repeated offers to purchase this little image were, unfortunately, of no avail; but it is hoped that this interesting and fine old statuette will one day find a place in a national collection where it belongs to.

KALHANA'S *Rajatarangini* mentions several times Trigarta and Jalandhara, but more important even than that, HIUAN-TSIANG, who visited the area twice, found in the spring of 635 A. D. over 50 convents of Buddhism, with some 2000 monks. Having spent there a considerable time, visiting monastery after monastery, the Chinese pilgrim must have had good reasons for giving those figures ; and to me at least it seems impossible that all those fifty monasteries and the attached sanctuaries should have disappeared without leaving a trace. I feel positive that systematic reconnaissance would reveal a number of old monastic establishments dating back to the early centuries of our era.

That Jains, too, were established once in the District is evident from a Sarada inscription of 1204 A. D. from *Baijnath*, giving the genealogy of the Princes of Trigarta, but another inscription in the temple mentions that the place was originally a shrine of Mahavira. (*A. S. R. 1905-6*, pp. 17 ff.). DR. VOGEL has given a proper account of this interesting temple, and his brief summary of it in his masterly chapter on Archæology in the *Kangra Gazetteer*, 1926, is strongly recommended to those interested in this shrine.

MR. H. L SHUTTLEWORTH, I C.S. (Retd.), is responsible for the discovery of a group of fifteen rock-cut temples at *Masrur*, some 12 miles from Nagarkot. These exceptionally interesting cave temples are profusely ornamented with rich decoration, and according to MR. HARGREAVES, belong to the 8th century or later.

In Kulu there is a temple of Hidimba Devi at *Manali*, with an inscription of the 16th century, to which, I regret to say, I am unable to find further reference.

The *Fort of Kangra Town* belongs mainly to the Sikh period, perhaps with the exception of the *Jahangiri Darwaza* which may well have been raised by the Emperor after his conquest of the Fort in 1620. The Fort had a number of Hindu shrines, which were reduced practically to a heap of ruins in the great earthquake of April 1905. Some of the remains indicate that though these shrines were mostly reconstructed in the Mughal and later periods, they contained carved stones of greater antiquity.

This, probably, is the case with the small temple of Indresvara in *Kangra Town*, portions of which may well date back to the 11th century A.D. The temple suffered much in the earthquake, particularly the pavilion of Siva's vehicle, the Nandi. Interestingly enough, at the entrance to the shrine of Siva there are two Jain images, one of them, of the Tirthankara Adinatha, bearing an inscription in Sarada characters. Remains of Jain shrines have also been found in the Kangra Fort.

Of more recent buildings mention must be made of the *Fort of Nurpur*, built in a Hindu-Mughal mixed style such as became the fashion during the tolerant rule of Akbar The central shrine is profusely decorated with carved ornament of an eclectic nature, and was probably built by Raja Basu, the founder of the Fort, who died in 1613, and destroyed by the Emperor Jahangir in 1618 when he led a punitive expedition against the rebellious son of the former King. This short lapse of time, no doubt, accounts for the interesting fact, clearly visible in the illustration, that portions of the wall-decoration remained uncompleted. (Plate II, fig. 2).

No reference will be made here to the antiquities of Chamba State, which, though of considerable interest, do not properly belong to an account of the Panjab, being situated in an independent State. The same applies to Bahawalpur, where particular interest attaches to the ruined Stupas near Sui Vehar.

It must be mentioned, finally, that Kangra is a most likely place for prehistoric antiquities, including remains of the Old Stone Age. Nothing, however, has been done so far in that direction.

Kurukshetra and other Ancient Sites.

One of the most promising areas from the point of view of the archæologist is the famous 'Field of the Kurus,' *Kurukshetra*, which, besides its importance as a place mentioned in the *Mahabharata*, will very likely yield many important remains of antiquity. Perhaps a comparison with ancient Troy would not be out of place. There too SCHLIEMANN, the founder of modern archæology, looked mainly for antiquarian evidence of the written tradition found in HOMER; and though, in his enthusiasm, he found what he believed to be perfect proof of many incidents in the *Iliad*, his operations proved far more important afterwards from quite a different point of view to the one he took.

The tank at Kaithal, the temples at Pehova, the scanty remains at Thanesar (Sthanesvara) and elsewhere, are mostly much more modern than the times of the *Mahabharata* battles; but they are, nevertheless, interesting and important monuments, though Thanesar was sacked, and probably raised to the ground, by Mahmud of Ghazni, and the only two inscriptions at Pehova date from the end of the 9th century A. D.

The same applies to *Theh Polar*, District Karnal, where MR. H. L. SRIVASTAVA, Superintendent, Archæological Survey, Northern Circle, Lahore, has carried out systematic work in the past three years. This, to my knowledge, was so far the only methodical piece of work done in the area of Kurukshetra, and we are looking forward eagerly to further results. MR. SRIVASTAVA's excellent account in the *A.R. Archaeological Survey 1930-34*, edited by the writer of these lines, gives the first account of the excavations; further work is being published in the subsequent volumes. The area can be described, I believe, more or less accurately, as not so much a fort as rather a fortified town. Many of the finds of the upper strata belong to the 13th and 14th centuries, including a considerable number of coins. But lower down the spade turned up remains belonging to the early centuries of our era, including many Yaudheya coins and seals. At the time of writing these lines the latest reports are not in hand: but there can be no doubt that important pioneer work is being carried out by the Archæological Department at that place.

Another area where there is plenty of scope for further work is the Salt Range and its neighbourhood. In *Jhelum town* itself several archæological finds have been made; the magnificent *ekamukha-Sivalinga* in the Lahore Museum was found when the railway was built; there can be no doubt that further finds would be made if it could be ascertained where this late Gupta sculpture comes from. According to reports the railway bungalows are situated on an ancient mound.

Rohtas Fort, some 10 miles north-west from Jhelum, was built in 1543, and is an imposingly large fort, in fact, far too large to be practical from a defensive point of view, for an immense army would be needed to man walls of such length. I believe, after a personal visit to the place in 1931, that clearance work would reveal interesting remains. In the small bazaar in the Fort, SIR AUREL STEIN and the author purchased some ancient coins of the Græco-Bactrian type. It is, of course, difficult to say where these coins were found.

The neighbourhood can boast of many other places of great antiquity. *Tilla* or *Jogi Tilla* probably existed in the times of Alexander's passage through the Salt Range; *Jalalpur*, the site of Boukephala, is built undoubtedly upon a mound of great age and Græco-Bactrian coins are found in abundance in the bazaar. Of *Bhera* we know that it existed at least as long ago as the times of FA-HIEN, the Chinese pilgrim (c. 400 A. D.), and Old Bhera is a protected monument well worth digging up. In this neighbourhood is the group of five mounds in the Rakh Chiragha, Bhera, starting with *Surkanvali Ali*, where the Punjab Exploration Fund carried out trial excavations last winter, and which they intend attacking this season by a licence from the Director-General of Archæology in India. These five mounds are probably the largest site hitherto discovered in India: and the writer of these lines found at least five successive cities buried under each other in the trial trenches, from the Mughal period back to præ-Buddhistic times.

In the Salt Range proper, *Nandana*, visited by SIR AUREL STEIN and the author in 1931, shows unmistakable signs of going back to early Buddhistic times, and excavations in the ancient Fort area would be promising. The temples of *Malot* date from the "Kashmir period," but there are signs of earlier structures there; the same applies to the group of Kashmiri temples at *Ketas*, which we examined in 1931. here unmistakable Buddhist remains are found on a lower level, opposite the present group of temples and may well be worth excavating. *Murti*, discovered by SIR AUREL STEIN and MR. FRED. H. ANDREWS in 1889, has probably yielded all that can be found; these carved remains of the ancient Jain Temple, mentioned by HIUEN-TSIANG, are now deposited in the Central Museum, where I have recently regrouped them in a more attractive and instructive fashion. Nevertheless, when we revisited the site with SIR AUREL in 1931, we thought that further excavations may still yield evidence of, perhaps, a monastic establishment. But there is little left on the surface There are later period temples (800—950 A. D.) at *Amb* and *Kalar*; the latter place is reported to be a large town-site with numerous ruins in the whole neighbourhood.

The following quotation from the excellent *Jhelum District Gazetteer*, 1907, will be of interest : "In addition to those which have already been mentioned, there are scattered about the district many old mounds and sites of former villages, most of them, as shown by the coins found, of great age :" a remark that may well be applied to all the other districts of the Province.

The compiler of the *Shahpur District Gazetteer*, 1918, remarks in a similar manner: " In the Bar tract between the valleys of the Chenab and Jhelum rivers there are some 270 mounds of earth mixed with loose bricks and fragments of pottery which mark the sites of former towns and villages." This figure, as will be seen, relates only to one portion of Shahpur District, so that my contention that the Province of the Punjab contains many hundreds of ancient mounds cannot possibly be an exaggeration.

A considerable number of ancient sites could be explored along the westernmost confines of the Province, on the banks of the Indus River. Personally, I have only knowledge of some ancient mounds near *Mianwali*, and some important finds of which I heard near *Attock*.

In the southern parts of the Province, the road from Lahore to Ferozepore can boast of numerous old mounds, *e. g.*, *Khana Kaccha*, *Kasur* and *Ferozepore*. *Hissar*, properly described in the *Hissar District Gazetteer* of 1916 as "full of antiquities," both the town and its neighbourhood, deserves to be properly explored. In many other countries such a district would have its "Hissar Antiquarian Society" or something of that kind but as there do not seem to be many people as yet interested in the antiquities of their neighbourhood, it is hoped that the Punjab Exploration Fund will one day turn its attention towards this district so full of promise. *Agroha*, 12 miles from Hissar town, has a mound of considerable extent, in which small scale digging was carried out as early as 1889, practically 50 years ago. A number of objects from that place are now exhibited in the Central Museum, Lahore. To my knowledge, nothing has been done since to discover whether it is true that the mound belongs to the præ-Christian times, a contention of the *Gazetteer*.

Many of the Islamic buildings in Hissar town are built with carved stones from older monuments of the

Hindus and Jains; the latter appear to have had a great hold on the ancient inhabitants of the area. *Hansi* town, in which there are several monuments protected under the Ancient Monuments Preservation Act, has a mound of considerable extent to the north of the town, parts of which were sold in the last century by auction. It would be worth while examining what is left. Several important mounds near the present, rather new town of *Sirsa* must be hiding the buried remains of the ancient Sarsuti. But one of the most promising sites in Hissar District appears to be the group of remains near *Tosham*, where probably a Buddhist establishment of some extent existed in the first few centuries of our era. A Sanskrit inscription on the hill is said to be dated of the end of the 1st century A. D., and there are remains of water tanks in the neighbourhood.

Another promising area in the south of the Punjab is the Rohtak District. Here, near Rohtak, Khokrakot or *Rohtasgarh*, excavations have been carried out some 30 years ago and during the season of 1937-38 the Archæological Department took up again the excavation of this old town-site. The results of these recent operations are unknown, but the fact that the Department turned its activities to that little explored region is most heartily welcome. The town of Rohtak, as some other places in the District, contains Mussalman buildings erected with the help of older Hindu carved stones. a site, called *Mohanbari*, is described as the largest deserted mound in the District; from *Bohr*, near Khokrakot, originate some of the sculptures in the Lahore Museum. These belong to the early medieval period.

A few lines will suffice to mention the great antiquity of some of the sites in Multan District. The town itself is supposed by CUNNINGHAM to go back to the 4th century B. C., according to a stratification obtained by him during a trench sunk by him in 1853. Many coins of the præ-Christian centuries are certainly found in and around the town. HIUEN-TSIANG visited the town and mentions it. Near *Tulamba* town is a huge mound called *Mamu Shehr*, probably marking the site of the ancient town "*Brakhmanon polis*" mentioned by ARRIAN. CUNNINGHAM and MASSON both visited the site, and the former mentions that the bricks he found there were of large dimensions (12″ by 8″ by 2½″) : a sure sign of great antiquity.

This enumeration, by far not a complete list of ancient monuments in the Punjab, must be considered rather as an indication of the large number of antiquities existing in this ancient and noble Province than a full account of them. I have had no opportunity to mention Manikyala, Sakesar, Mong in the Gujrat District (identified by CUNNINGHAM with *Nikaia*), and worst of all, I have made no mention of the many hundreds of important and beautiful monuments of the Mussalman occupation of the Punjab. As to the latter, the Islamic monuments are mostly protected and well looked after, and there is little that archæologists can do with them, except in the matter of architectural history and conservation. How well cared for these monuments are, visitors to Lahore can observe best by visits to Jahangir's Tomb and to the Old Fort in Lahore; a considerable amount of excavation has been carried out in the latter during the last ten years. Multan and many other Districts abound in monuments of the Muslim period, and, of course, the Sikhs possess the greater majority of their monuments in the Province which was always the stronghold of their faith.

Nevertheless, it must be evident that the major portion of the work before the archæologist relates to the older periods : the period of the Stone Age, remains of which must be found from Kangra to Gurgaon, from the ancient hills of the Siwalik Range (where some stone implements have been found recently) to the entirely unexplored areas round Dera Ghazi Khan; then the præ-Buddhistic periods, of which practically nothing is known: and the Buddhistic times, of which very much more may be learnt and found : finally the Hindu period of the early Middle-Ages, before the Muslim invasion, the archæology of which is in a very poor state everywhere in India. As soon as we come to the Muslim times, historical and antiquarian evidences suddenly become richer; and though I do not, for a moment, suggest that these later periods are less interesting, I do emphasize that there is greater lack of knowledge in the preceding epochs and greater need for further research work.

As already mentioned before, the archæology of this very ancient country cannot proceed properly, unless the greater public is made interested in it. The Archæological Survey of India are faced with a gigantic task which they cannot be expected to tackle quite alone; they need the co-operation not only of educational institutions but of the greater public too. For it is the greater public that visit the museums, send their sons to colleges, and vote for grants in the assemblies of the Nation Upon them depends the prosperity of archæological work; and the success of the Punjab Exploration Fund conclusively proves that there is a class of *intelligentsia* that is truly interested in the subject and willing to support serious archæological work. Although this public is, as yet, small, it depends upon the excavators and field workers to rouse more interest in them: otherwise archæology in this Province, as elsewhere, will progress with a snail's speed.

CHAPTER VII

FORESTRY AND ITS SHARE IN RURAL RECONSTRUCTION

BY

R. MACLAGAN GORRIE, D. Sc., I. F. S.

SECTION I

ECONOMIC POSITION OF PUNJAB GOVERNMENT FORESTS.

Although the economic development of the Punjab is a favourite theme of the day with economists and politicians, it is curious that neither the development of forest resources nor the part which foresters might play in the future development of the Province has received the publicity it deserves.

At present the hill forests which are economically the most important have not been developed to their full commercial possibility. The chief reasons are in the lack of communications, and in large tracts of valuable forests being unworkable owing to their inaccessibility. Steady progress has been made in their development by the gradual extension of roads and railways, but the main means of extraction must remain by floating timber down the Punjab rivers. There are 6,078 miles of forest land in the Punjab or 6·7 % of the total area of the Province. Of this 2,067 square miles are under conifers, and 4,011 square miles under broad-leaved trees. Small as the total forest area is compared with other Indian Provinces, the position from the economic point of view is even less satisfactory than would superficially appear, because in the case of conifers the area unprofitable for working is 64 per cent. while in broad-leaved forest 90 per cent. is unprofitable. The quantity of wood found growing per square mile of the forest area varies within wide limits, but is on the average estimated at 906,000 cubic feet for conifers and 219,000 cubic feet for broad-leaved forests.

The annual revenue from forest produce is about Rs. 22 lakhs and is made up as under:—

Timber	11,70,000
Fuel	4,00,000
Grazing Grass }	1,50,000
Resin	2,00,000
Other Produce..	2,60,000
Bamboos	20,000
Total ..	22,00,000

In addition to this, the value of free grants of forest produce, mostly building timber, fuel, grass and grazing, reaches the very large total of Rs. 25 lakhs, but unfortunately this sum has never been taken into consideration when the departmental budget is framed by Government.

SECTION II

FOREST TYPES AND THEIR ECONOMIC VALUE.

Different types of forests which are met in this Province are distributed according to the climatic conditions which are mainly governed by the amount of rainfall and the altitude. The Punjab plains are at a great distance from the sea, and almost beyond the range of the active monsoon current. In the extreme north-west this current has become thoroughly dried up before it ever reaches there, so that the rainfall at Lahore is about 20″ and in the districts west and south of it is less than 10″. The result is an extreme "continental" climate, very hot in summer and very cold in winter. On the other hand on the southern slope of the Outer Himalayas particularly in the eastern foothill districts the rainfall is heavy, as the monsoon in its westerly course strikes against these hills.

The following types are easily distinguished :—

1. Hill forests.
2. Scrub forests, including bamboo.
3. Thorn savannah of unirrigated plains.
4. Irrigated plantations.

1. HILL FORESTS.

Economically the coniferous forests are the most important because they include *deodar* (*Cedrus deodara*) *kail* (*Pinus excelsa*), *chil* (*Pinus longifolia*), tos or fir (*Abies pindrow*) and *rai* or spruce (*Picea morinda*), all of which are commercially valuable.

Each of these trees has a fairly well marked altitudinal zone. The different zones form more or less parallel belts but these are considerably modified by aspect, rainfall, etc., which have a marked influence on tree growth. Thus under favourable conditions of moisture and soil, trees of one zone are found growing in another to which they do not ordinarily belong and this gives an appearance of irregular distribution and overlapping. The occurrence of well-defined altitudinal belts is nevertheless a striking feature.

Chil.—The *chil* forests occur at 3,000—6,000 feet and are commonly found on poor shallow sandy soils. In moist situations with deep soil, broad-leaved trees which are common in the adjacent scrub forests replace the *chil*. However, the typical *chil* forests contain very little of tree growth other than *chil*: the foresters say that the *chil* occurs " pure. "

The annual output of *chil* timber is about 1,850,000 cubic feet in the round. The timber is only slightly inferior to *deodar* in strength, takes antiseptic treatment easily, and is much used for sleepers treated in this way, and for construction purposes. There is no accurate figure for the amount of *chil* used as fuel, but it must be a colossal quantity, because every town, village and farm along the foothills uses *chil* firewood gathered free

The value of *chil* does not reside exclusively in its wood : it is the chief source of supply of resin of which about 40,000 maunds are extracted annually and the wages paid for its collection save many villagers in the Murree, Kangra and Hoshiarpur foothills from starvation when their crops are poor.

Blue pine.—Just above the limit of the *chil* zone, blue pine forms a belt at 6,000—8,000 feet. Near the lower edge of its zone, white oak is found mixed with it, but further up it occurs pure, though in many places blue pine is also found in the company of *deodar*.

Blue pine forests yield about 925,000 cubic feet of timber. The wood is the cleanest of Indian pines, and is much used for interior construction and furniture, etc. It also makes good treated sleepers. Blue pine yields a light grade of resin, but collection is difficult owing to the short cool summer, and it has not yet been exploited for resin.

Deodar.—At about 6,000—8,500 feet *deodar* forms blocks of forests which though extensive are by no means uninterrupted, for instance it is absent from the Dhauladhar ridge above Dharamsala in the Kangra District. It is sometimes mixed with blue pine but is mostly pure towards the middle of its zone. Towards its upper fringe it is mixed with firs, and near the lower limit, its place is taken by chil.

Mature deodar reaches 150 feet in height with a diameter of 36″ but trees considerably smaller than this diameter are felled for commercial use. Of course single trees or groups of much larger dimensions occur and over 30 feet girth has occasionally been recorded for old trees which have been saved from the axe because they are connected with some temple or holy ground.

Deodar wood is the stron est and most durable among the Indian conifers, and much in demand for building, bridge construction and railway sleepers. At least 50 per cent. of the wood used in Punjab house construction is deodar, nd in the hills where it occurs, almost 90 per cent.

Spruce and silver fi .—The forests at 9,000—12,000 feet are almost entirely composed of fir, mixed lower down with deodar and towards the top of their zone they are mixed with brown oak. Spruce and silver fir grow to be large trees but are not as long lived as deodar. Large spruce tend to be hollow or soft in the centre of their systems.

Broad-leaf trees—The hill forests also contain a large area of broad-leaved species which could yield valuable hardwood timber. The supply is, however, fast dwindling, chiefly due to the lopping of leaves and branches for cattle fodder. Taking into considerations the present condition of these trees in the Kangra and Murree hills it can be said for certain that they are doomed to extinction within a short time unless the people can be taught to protect their own broad-leaf forest. The vital importance of this type of forest for water conservation is discussed later in this chapter.

The common broad-leaf trees are: grey oak (*Quercus incana)*, green oak (*Quercus dilatata*), brown oak (*Quercus semecarpifolia*), horsechestnut (*Aesculus indica*), the tree rhododendron (*R. arboreum*), poplar (*Populus ciliata*), elm (*Vimus laevigata)*, and a number of *Acer*, *Rhus* and *Alnus* species.

Scrub Forests.

These occur on the low hills flanking the Himalayas below 3,000 feet and on the elevated plateaux between Jhelum and Indus. They contain a large number of trees and shrubs of practically no value except for fuel and rough building poles. Although some of the trees comprising these forests such as *chal* (*Anogeissus latifolia*), *sain* (*Terminalia tomentosa*) and *sandan* (*Ougeinia dalbergioides*) are capable of attaining timber size they are almost always on the worst soil, because the better soils are cultivated, so that trees are not usually big enough for timber. Other small trees include *kau* (*Olea cuspidata*) *phulai* (*Acacia modesta*), *kikar* (*Acacia arabica)*, and many others which are of use for firewood, fencing material, and lopped fodder.

Bamboo forests occur within the limits of the scrub-forests which they resemble, but are distinguished by a large percentage of bamboos. The annual output of bamboos is about 400,000 and is valued approximately at Rs. 20,000. The recent development of bamboos as a raw material for Indian paper manufacture is of great interest, but the Punjab bamboo forests will only supply a fraction of the paper mill requirements Meanwhile unfortunately some of our bamboo areas remain congested because it does not pay to work them.

Thorn Savannah of Unirrigated Plains.

These are the virgin forests of the arid plains, with a dry climate and semi-desert conditions. The trees and shrubs are widely scattered, and much stunted. They include many thorny trees like *jand* (*Prosopis spicigera*), *phulai* (*Acacia modesta*), and *kikar* (*A. arabica*), also *van* (*Salvadora oleoides)*, *karir* (*Capparis aphylla*), etc. In this Province extension of irrigation has proceeded at the expense of these rakhs, which have been disforested, and have now to a great extent disappeared, though relics of them can still be seen in hedgerows and uncultivated land.

Irrigated Plantations.

These have been created out of **rakhs** with the use of irrigation, and have developed into a valuable source of fuel and certain kinds of timber. The annual supply of fuel is nearly 280,000 cubic feet. The following statement gives the distribution of these plantations :—

Name of plantation		*Area*	*Year started.*
Chhanga Manga	..	12,516	1866
Chichawatni	..	9,085	1913
Khanewal	..	16,509	1916
Terah	..	837	1917
Daphar	..	6,598	1919
Miranpur	..	10,006	1929
Arafwala	..	9,839	1929
Dipalpur	..	9,537	1929

The *shisham* (*Dalbergia sissoo,* in Punjabi, *tali*) is one of the commonest roadside trees in the Province, and a valuable timber for construction and furniture ; the mulberry (*Morus alba*, in Punjabi *tut*) is the backbone of the sports manufacture in Sialkot, but the annual output of 50,000 cubic feet of mulberry timber is hardly sufficient for the demand, and suitable timber is apparently only produced upon a deep forest soil which has been built up after many years of irrigated forest conditions. Another useful species is the Persian lilac (*Melia azedarach,* in Punjabi *drek* or *bakain*), which is a useful light timber and is a harder species than the other two in times of water shortage. The *farash* (*Tamarix articulata*) is useful on bad ground and as a nurse to give shelter to more tender species which will not grow on exposed ground ; its wood has previously been neglected but is now in demand as a substitute for turnery woods.

These irrigated plantations produce a steady revenue for Government and give employment to a large number of people, both in the woods themselves, where neighbouring cultivators find work when farm work is slack, and in the many cottage industries and wood using concerns throughout the Province. The total revenue figures for Chhanga Manga plantation for the 22 years, 1913 to 1936, are : Revenue, Rs. 81,60,900 ; Expenditure, Rs. 73,72,600 ; Surplus Rs. 43,88,300. Up to 1880 the cost of formation of this plantation had accumulated to Rs. 5,48,270 and a Profit and Loss account had been maintained which showed that after allowing interest on capital at 4 per cent., the whole debit balance had been cleared off by 1913, so that the whole of the above surplus is clear profit to the State.

SECTION III

EROSION AND DENUDATION FOLLOW DESTRUCTION OF FORESTS.

The value of forests is not confined to the direct benefits of forest produce. The indirect benefits are of very great importance. There can be no question that the floods which have been causing much havoc in the plains could be to some extent controlled by proper conservation of the foothill country. In the Hoshiarpur, Ambala and Jhelum districts the decay of forests has become a matter of public concern. A striking instance of the effect of denudation is furnished by the Hoshiarpur *chos.* This extensive region of low hills which was once covered with forests, has now become a desolate waste. At first the timber was removed, then the inhabitants set to work on shrubs followed by extraction of stumps and roots, so that the ground was completely bared. With the removal of plant cover the work of wind and water erosion quickly began. Great fissures and gullies opened up and rain water carried away all the eroded material with it. This denuded tract is remarkable for the floods of extraordinary violence which sweep over the country far and wide. The Forest Department has entered on the work of restoration of grassland and forest and a large number of trees and other plants have been planted, with the help of those who have been persuaded to recognise the value of this work, but once destruction is complete the process of recovery is slow and costly. A successful example of reforestation work can be seen in the Pabbi hills astride the Grand Trunk Road between Kharian and Jhelum.

There has been a popular impression in the Punjab that the whole of the hill country and other wild lands of the Province are being looked after by the Forest Department, but actually this department holds only a very small percentage of the vitally important foothill drainage areas, and even in the forest reserves its hands are tied by legally binding but ridiculously generous forest settlements under which effective control of grazing and other destructive customs is more or less impossible. The remainder is in village lands and in several Indian States where over-grazing and other misuse of lands, such as bad cultivation methods, are widespread.

SECTION IV

RIVER CATCHMENT AREAS AND THEIR EFFICIENCY.

The entire flow of a river can seldom be used by man, for a large percentage is inevitably lost in uncontrollable floods. The measure of a river's efficiency is its average flow—in the case of town supplies, its average clear-water flow. Anything that interferes with the regularity of this flow is of importance. Any increase in the runoff from rain will tend to increase the effects of erosion also, and floods are the cumulative effect of both. Similarly, droughts are intensified by any reduction in the efficiency of a catchment area because a poorly covered slope loses a large percentage of rainfall as immediate runoff: correspondingly less water is caught and stored underground; and the reserves that feed the deeper springs in times of surface shortage are thus depleted. The remedy lies, of course, in the maintenance of a plant cover on the vulnerable foothill areas. In the Punjab the destruction of the plant cover of the foothills is an extremely complex problem, the seriousness of which has so far been realized by only a few.

The western Himalaya rises from the Punjab plains in a series of outlying ranges, gradually increasing in height from the outer low ridge of the Siwaliks, only a few hundred feet above the neighbouring plain, to the main ranges, 60 to 80 miles beyond, with their 20,000-foot peaks. An exception is found in Kangra where the stupendous cliffs of the 15,000-foot Dhauladhar tower above the outermost valleys. The rainfall decreases rather rapidly from south-east to north-west along these hills. From a total of about 120 inches above the Kangra valley it decreases to a scanty 30 inches at the same altitudes in the Rawalpindi and Hazara hills, and on the plains it decreases from 40 inches to 10 inches from east to west. There is also a marked altitudinal variation, because the full force of the monsoon storms strikes the hills at about 4,000 feet. Both about and below this wettest belt the rainfall decreases appreciably, and the winter snowfall reaches an appreciable depth only above 9000 feet. Hence it will be seen that the foothills bear the brunt of the onslaught of the monsoon storms, and their condition is a vital factor in the water conservation of the Province.

The amount of erosion and its effect on the water regime are shown by some data of torrent intensity collected in an arid tract of low hills known as the Pabbi Hills, which stretch south from the main foothills along the east bank of the Jhelum River opposite the cantonment and city of Jhelum. The Pabbi Hills are a low ridge of deeply eroded Siwalik sandstone and shale and show a variety of conditions of plant cover. The irrigation staff have had considerable difficulty in maintaining the Upper Jhelum Canal in face of the torrents which run at right angles to it and for which some form of siphon or discharge weir must be provided to prevent damage to the canal. In the course of their duties the irrigation staff have collected the runoff, or rather the peak flood discharge, for a large number of the torrents. Recognizable cover types and the runoff data associated with them are as follows :

1. Part of the land has been under a regime of afforestation and countererosion work for about fifty years; such land, although not fully covered even when fully protected, yields a maximum runoff of less than 100 cusecs (cubic feet a second) to the square mile, enables cultivation close to the streams that drain from it, and yields a revenue of one rupee an acre for grass cutting.
2. Similar land under a passive regime of protection against grazing but with no active afforestation or gully-plugging work yields a maximum of 600 cusecs to the square mile.
3. Similar land under grazing, partly but ineffectively controlled, yields 1,000 cusecs. Its revenue is one anna an acre for grazing and no cultivation is possible within a very wide strip of sandy waste that borders the resulting torrent bed in the flat lands below.
4. Where persistent cattle and buffalo grazing has destroyed the cover and reduced the area to slopes of shifting sand anchored only by the relics of scrub jungle, the runoff rises to the alarming figure of 1,600 cusecs.

These figures are for small individual catchment areas of two to ten square miles, and the figure of 1,600 cusecs to the square mile represents an extremely high percentage of runoff, about 90 per cent. of the rainfall of the typical sudden torrential downpour falling on ground previously parched by drought.

A further serious source of damage to the plant cover that nature originally provided is to be found in the system of field cultivation used in the foothills and also in the higher hills up to the level at which summer cultivation is attempted, namely about 10,000 feet. In the lower hills and on gentle slopes the standard of terracing is on the whole fairly good; and in certain tracts such as the Jhelum Salt Range the method of leveling fields is very efficient indeed—by means of either stone walls or plowed earth scooped up into contour ridges. This, however, is the exception, and elsewhere the use and maintenance of *watt bandi* (the Punjabi equivalent of contour ridging) are sadly neglected or unknown. In the hilly and more primitive tracts the steepest hillsides are stripped of their cover, often by burning the forest, and are dug by hand because they are too steep to plough. The result is an appalling waste of soil, which is washed away at the rate of as much as 150 tons or even 200 tons an acre a year, and each field is capable of producing potatoes for only three or four years, after which it reverts to village grazing. Persistent grazing prevents the re-establishment of the previous forest cover, and the ground is eventually reduced to a bare and unstable scree of stones. With this destruction taking place over large areas of extremely steep country exposed to the terrific onslaught of the monsoon rains, it can be imagined just how serious the effect is likely to be on the water regime of the country as a whole.

SECTION V

NEED FOR WATER CONSERVATION.

The water resources of the Punjab have so far been mainly utilized by feeding each of the large rivers directly into one or more irrigation canals without any storage reservoirs. These canals were planned for perennial irrigation but only the *kharif*, or summer crop, receives an adequate supply of water. This is ensured by the fact that the snow melt of the high hills reaches its zenith in June and combines with the monsoon rains of the lower hills to produce more water than can be used. The *rabi*, or winter crop, on the other hand, seldom gets enough water for even small areas of sowings, and in bad years the canals are run in the winter only to meet the domestic needs of the canal colonists. Vast quantities of water go to waste in the summer, but there is not enough to go round in the winter, so that the great imiting factor in the prosperity of these ten million acre of canal colonies is the scarcity of winter water.

Recently an ambitious hydro-electric project has been launched and has met with unexpected success in so far as demands for distribution of power have exceeded the engineers' most sanguine forecasts. The power is derived from the Uhl River, the water of which is passed through a three-mile tunnel to Jogindernagar, in Mandi State, where the turbines are situated. The total planned load will require 400 cubic feet a second, but the level of the river usually drops to 100 cusecs or less for a few days each winter, so that some form of storage reservoir or a supplementary coal-burning plant is projected. A detailed survey of the catchment area has yielded some interesting data.

The catchment area of 150 square miles rises steeply from the valley bottom, at 6,000 feet, to the Dhauladhar ridge, at 17,000 feet. Four distinct belts are recognizable : (1) farm cultivation and grazing land in the valley bottom running up to (2) a belt of forest of oaks and conifers from 9,000 to 11,000 feet, then (3) alpine meadowlands from 11,000 to 13,000 feet, and, last, (4) the upper limits of rock, glaciers, and snow-covered scree slopes above the tree line. The alpine meadows are badly cut up in places as a result of the visits of immense itinerant flocks of goats and sheep, led by their picturesque Gaddi owners in their Greek kilts. The forest belt is also affected to some extent by the visits of these flocks, for the oaks are failing to re-establish themselves because the seedlings are being persistently browsed. The cultivators encourage the flocks to stay because this is their only means of manuring their outlying fields. The worst phase of the water regime, however, is found in the farm belt, which is being stripped of its soil cover by the extension of unterraced cultivation and by the large amount of grazing on all uncultivated land. This is the more serious for the reason that the land above 9,000 feet is in any case inactive during the winter because it is frozen under a pall of snow that does not melt appreciably until about March and April. The only hope of a sustained winter runoff is to restrict both cultivation and grazing and to reforest those areas of fields and pastures that are being most seriously eroded.

SECTION VI

THE GRAZING PROBLEM IN THE PUNJAB FOOTHILLS.

In the foothill grazing grounds almost every kind of live-stock competes for a living—milk cattle, plough cattle, water buffaloes also used for milk and plough, sheep, goats, camels, donkeys, mules and pack bullocks, *plus* huge migratory flocks of sheep and goats which descend from the high hills every autumn to the adjoining plains, like locusts in their numbers and powers for sheer destruction The better-known breeds of Indian cattle such as Hissar and Dhanni are bred only in areas where there is practically no common grazing ground left, or are kept as pampered pets stall-fed by the household to which they belong. Where the people have been forced to rely entirely upon stall-feeding they have naturally concentrated upon fewer and better animals. The awful deterioration in the type of cattle wherever common grazing still persists as the usual practice is a most striking and consistent feature of Indian animal husbandry. This deterioration is seen at its miserable worst in all districts containing large areas of wild land too steep or too poor for cultivation, and, therefore, includes the whole of the Western Himalayas and the many ranges of lower hills further south. As the farm community alters towards the grazier type, the daily milk output per cow drops from somewhere about sixteen or twenty lbs of milk to less than a ¾ lb. This is no exaggeration, the average village cow in the foothills seldom yields more than a ***chittank***, which is two ounces

Apart from grazing, the food resources for animals comprise (*a*) straw and stubble from crops such as rice, wheat, and sugarcane ; (*b*) leguminous and other fodder crops ; (*c*) cut grass : and (*d*) tree loppings. Rice straw is the mainstay in many districts but is not in itself a maintenance ration. Lander and Dharmani place the value of Kangra rice straw as well below this standard, which is the minimum digestible protein needed to keep a cow fit when not working ; it would not provide for a plough-bullock at work nor for a good milker. Wheat straw is somewhat better in food value, but the amount available is sufficient only for a short time after each harvest. The chief fodder crops are juar (*Sorghum durra*) and in irrigated tracts berseem and shaftal, (both forms of clover) and lucern : again the amount of these fodder crops is in inverse proportion to the amount of wild grazing land available, and the poorer districts have such a hard struggle to grow their own food crops that they cannot grow any fodder. This is a point which many animal husbandry enthusiasts have failed to grasp.

The value of cut grass is also pretty low in the foot-hill areas, partly owing to the natural poorness of the grass crop from land which is heavily over-grazed for at least nine months in the year, and partly owing to the method of harvesting the grass. At the time when hay ought to be made in the months immediately following the monsoon, the cultivator is busy with his autumn ploughing, so the cutting of grass is inevitably delayed until only the dry bones of the grass crop are left. It is not possible to alter the agricultural calendar, so improvement appears to lie along the lines of grass cultivation by contour ridging and, by any other means which will keep the grass longer green. The possibilities for the improvement of wild grasslands along such lines are tremendous, but so far are practically untouched. Possibly the best samples of ordinary foothills grass crops are harvested by the Military Grass Farms from areas which they hold or lease, and the analyses of these show that very few of them constitute a maintenance ration, though these are above the village average in so far as closure is enforced for the whole year instead of only the monsoon months.

A peculiar feature of Indian animal husbandry is the dependence of many localities upon tree loppings for fodder. In the oak zone of the lower hills at 4,000 to 6,000 feet *Quercus incana* and *dilatata,* in the higher hills *Quercus semecarpifolia*, and in the more arid hills *Quercus ilex*, are all very heavily lopped ; so heavily in fact that one or other is being completely driven out and destroyed over large tracts. *e. g*, *Quercus dilatata* in the Murree hills, *Quercus incana* in Kangra. The same thing applies in a still lower zone where *Olea cuspidata*, the wild olive, still persists in face of very heavy misuse in the limestone and sandstone of the Jhelum Salt Range and other arid hilly tracts below 3,000 feet altitude. The combination of persistent grazing, browsing and lopping under an exceedingly arid climate is more than even this hardy species can stand, and it is disappearing from a landscape already devastated by erosion.

SECTION VII

THE FORESTER'S CONTRIBUTION TO RURAL DEVELOPMENTS.

So far back as 1870 forest officers have constantly been calling attention to the serious denudation of the Punjab foothills, and the disastrous results which must inevitably follow. In addition to developing to a high standard the management of the relatively small part of the Province which they were given charge of in the form of forest reserves, they have foretold the inevitable effect of persistent over-grazing on the areas outside the forest reserves. It is, however, only since the introduction of the Rural Reconstruction programme that they have been given any opportunities to deal effectively with this menace outside the limits of reserved forest. Until recently the Punjab forest officers have advocated closure to grazing as the only feasible means of restoring the plant cover to its natural condition, and thus reducing the runoff and loss of soil. This of course is still the main line of attack, but considerably more can be done if the various phases of misuse of land are taken up under improvement schemes which deal with bad agricultural as well as bad grazing methods, and a better conception of the essentials of sound live-stock farming is shown by demonstration and education, rather than merely insisting upon reduction of the sheer weight of numbers of cattle and goats.

Much of the erosion loss occurs in areas where so far no department of government has made itself responsible for teaching and improving local methods; therefore, in projects recently outlined the need for closer co-operation between Forest, Agriculture, Veterinary, Animal Husbandry, and Revenue staffs has been emphasised. Fundamental changes in the lives of the very conservative farmers and graziers cannot be brought about suddenly, and can only be effected by a long-range programme working steadily towards the aims in view. The various lines of approach can perhaps best be summarised under the three headings of ploughland, livestock with fodder production, and afforestation works :—

(a) Ploughland

(*a*) Contour ridging and terracing: improve where already in use and introduce where unknown.

(*b*) Remission of revenue to encourage contour ridging.

(*c*) Consolidation of holdings to facilitate planning of field layout.

(*d*) Planning and proper terracing of field drains in tea gardens and orchards to carry off surplus flood water.

(*e*) Co-operative loans for land improvement.

(*f*) Use of livehedge plants to replace cutting of dry thorn branches: and proper alignment of hedges.

(*g*) Capture and use in fields of road runoff where this contributes to erosion

(*h*) Encourage use of compost manure and use of green manuring crops.

(*i*) Rotation of crops and "strip cropping" with soil binding crops.

(*j*) Find legume or grass crop to sow on fallow.

(*k*) Gully plugging to stop deep erosion in and between fields.

(*l*) Improve cultivation of wasteful crops such as potatoes

(*m*) Restriction of cultivation on very steep slopes.

(*n*) Refuse sanction to break virgin land on vulnerable slopes.

(*o*) Provide fuel supply to eliminate burning of cowdung.

(*p*) District civil staff to be given short courses in erosion control.

(b) Livestock and Fodder.

(*a*) Encourage voluntary and rotational closures.
(*b*) Legislation to extend application of closures
(*c*) Partition of common lands.
(*d*) Village Committee or Co-operative Society management of grasslands.
(*e*) Replace grazing by grass cutting and stall feeding.
(*f*) Grassland improvement by contour ridges and water catching.
(*g*) Develop grass and hay markets.
(*h*) Green fodder crops and silage.
(*i*) Emergency fodder crops, *e. g.*, spineless prickly pear.
(*j*) Planting of fodder trees.
(*k*) Rotation of lopping fodder trees
(*l*) Control migratory flock movements and reduce per cent. goats in flocks
(*m*) Application of cattle or livestock tax to encourage good type of milch and plough cattle and eliminate useless scrub animals.
(*n*) Reduction of surplus livestock.
(*o*) Grading up of flocks and herds by maintaining stud animals and segregating male goats, castration, etc
(*p*) Determine palatability of local grasses and fodders.
(*q*) Feed mineral salts as " licks " to compensate for deficiencies in local fodders.
(*r*) Search for improved strains of grasses both local and foreign.
(*s*) Improve watering arrangements with dams, tanks, wells, etc.
(*t*) Develop market supply of meat and humane killing in slaughter houses.
(*u*) Improve grading and marketing of hides.

(c) Afforestation and other works.

(*a*) Reclamation of ravined lands for fuel and fodder production.
(*b*) Reclamation of flat lands in torrent beds by stream training.
(*c*) Establish shelterbelts where advisable.
(*d*) Village plantations for fuel, timber and fodder.

(*e*) Planting of fodder trees in grasslands and rotation of lopping.

(*f*) Control of grants for fresh cultivation in village waste and scrub jungle.

(*g*) Protection of existing forest.

(*h*) Encourage village as the unit for organising forest improvement and protection schemes by *panchayat* or Co-operative Society.

(*i*) Special legislation for control of vitally important catchments.

(*j*) Runoff control and contour trenching and water catching bunds in forest land.

(*k*) Closure of dangerous landslips and their vicinities.

CHAPTER VIII

PUNJAB CANALS

BY

BAWA NATHA SINGH, R. B., I. S. E. (Rtd.)

Extent of the Province.

The Punjab, as at present constituted for administrative purposes, is bounded on the east by the Jamna River and on the west generally by the Indus River. Between these two rivers, there are five others traversing the tract. Thus though the Province derives its name from five rivers, there are actually seven rivers comprised in it at present. All these rivers have their sources in the Himalayas and have a perennial flow. In the winter they are fed by snow and in the summer both by snow and rains. The channels of these rivers in the plains spread for several miles across their width and the volume of water they carry in summer may be roughly put at 100 times what they carry in winter. The country lying between the rivers is generally flat sloping gradually from the Himalayas towards the neighbouring Province of Sindh. The soil except in small patches here and there is fertile consisting of sandy loam eminently suitable for propagation of all kinds of crops and fruits.

Suitability of the Area for Canal Irrigation.

The rainfall varies from about 40 inches in the submontane districts to about 5 inches in the southern districts on the borders of Sindh and Bahawalpur. This rainfall is unequally distributed (over the seasons of the year over 80 per cent. falling in the months of July, August and September) and is not available when required for the sowing or maturing of crops. Over most of the area the total amount is less than 15 inches, which is quite insufficient for the cultivation of valuable crops.

The ground water table is very deep in the tract in which rainfall is deficient, being sometimes over 80 feet below ground. The subsoil water is brackish, so that no irrigation is possible from wells. The tracts in which water table is close to the surface possess a large number of wells, but the area irrigated from a well is not more than 25 acres and the cost of the well is beyond the means of a small landholder.

The conditions for canal irrigation in the Province are thus more favourable than in any other Province of India. Rainfall is deficient, well irrigation is possible only in a limited tract, abundant water is available in the rivers throughout the year, and the country is flat and eminently suitable for flow irrigation and the soil fertile.

Early Irrigation Works and Area Irrigated.

These conditions have existed in the Province for centuries, but it was not until Science came to be applied for the use and convenience of man that canal irrigation became a practical proposition bringing in prosperity and plenty to the inhabitants of the Province. Only about 80 years ago, the land offered a precarious source of livelihood to the cultivator. Famines were frequent and immense tracts of land were capable of supporting only a sparse population of nomad cattle graziers. Cultivation was confined to low lying tracts along rivers or submontane districts where well irrigation was a possibility or rainfall was sufficient. The only canals then existing were :—

(*i*) The Hash Canal of Akbar and Shah Jahan, dug by the well-known engineer Ali Mardan Khan for conveying the water of the River Ravi for the Shalimar Gardens at Lahore.

(*ii*) The Jumna Canal of Feroze Shah Tughlak constructed for the irrigation of the gardens at Delhi and Hissar.

(*iii*) A few Inundation Canals from Chenab, Sutlej, Indus, etc., constructed by the joint efforts of the irrigators themselves for irrigation in the low lying areas along the rivers.

The total area under canal irrigation by these primitive methods was about 400,000 acres, but there being no means of controlling the supply to the canals, the irrigation was spasmodic and the maturing of crops uncertain. Plate II shows the area under canal irrigation in the year 1865 which is the earliest year for which statistics are available.

The year 1868-69 is the first year for which statistics of cultivated area of various kinds are available. The figures were:—

Canal irrigated	1,373,000	acres
Well irrigated	4,612,000	,,
Barani	14,187,000	,,
Total	20,172,000	,,

Expansion of Irrigation by Scientific Methods.

With the advent of British Rule came the engineer with his scientific methods of tackling the problems of applying the abundant water of the rivers, which was running to waste in the sea, for the irrigation of the thirsty lands. The problem presented numerous difficulties in an undeveloped country without any roads or railways but with persistent labour, perseverance and hard work, the engineers with the aid of science have produced a canal system in the Province, which is more extensive in its scope and magnitude than any other irrigation system in the world, while its engineering works are a model for other countries in their conception, design and magnitude.

Prosperity of the Province due to Canals.

That the prosperity of the Province is entirely due to its canals will be clear from the following approximate figures of cultivated area and income at present:—

Average area irrigated by canals	12, 000, 000 acres
Percentage of the total cultivated area in the Province	47 per cent.
Average annual net revenue to Government from canals	Rs. 5,00,00,000
Value of crops raised annually on the Canal irrigated area	Rs. 39,00,00,000

When we remember the revenue that is added to the Government coffers every year and the value of the crops that is added to the coffers of the cultivators, we get some idea of the enormous wealth produced by canals. Plate III shows the increase in the net revenue earned by the canals year by year to the end of the year 1935-36. The accumulated revenue in 1935-36 amounts to the colossal figure of Rs. 1,15,53,94,463.

Development of Canal Irrigation.

Plate IV shows the area irrigated by the canals at present. If we compare this map with the area shown in Plate II, we get a bird's-eye view of the vast development that has taken place in the area steadily brought under cultivation from year to year.

Plate IV shows diagrammatically the steady increase in the area irrigated, in the total area brought under cultivation, and in the population from the year 1884-85 to the year 1934-35. The figures in the following table show the development of the Province in other directions as a result of canal development :—

Year	Railway mileage.	Metalled road mileage	Land Revenue (Lakhs Rupees).
1872-73.	410	1,030	201
1882-83.	600	1,467	206
1892-93.	1,725	2,142	22
1902-03	— —	— -	23
1912-13	4,000	2,614	360
1922-23.	4441	2,938	400
1932-33.	5,500	3,904	428

This development is not yet at an end. The area in pink wash in Plate I shows the proposed irrigation from canals either already under construction or likely to be taken up within a few years. A description of these new projects is given on subsequent pages. The new area likely to be brought under canal irrigation in a few years time by new projects will be about 17½ lakh acres, *i.e.*, about 15 per cent. increase over the existing irrigated area.

Capital Expenditure on Canal Construction.

Here it would be interesting to have an idea of the capital expenditure incurred on the construction of these canals. Plate VI shows the progressive increase in this capital from the year 1865 to the year 1935. Starting with a capital of about 1½ crores in 1865, it mounted up to nearly 34 crores in 1935 and must be about 38 crores at present. All this expenditure has been met from loan funds and the return to Government is nearly 13 per cent. Plate VII shows the area irrigated from year to year from 1888 to 1935 and Plate VIII shows the value of crops raised during the same period. These diagrams and the one on Plate III give a complete picture of the financial position of the Punjab Canals. What a valuable asset they constitute for the Punjab Government and what source of wealth they mean to the agriculturists of the Province !

Description of the Canal Systems.

Now we will give a brief description of this wonderful canal system. For a proper understanding of the subject, we will first briefly explain in general terms the various works that constitute a canal and what is the particular function of each work.

There are two types of Canals in the Province :—

(*i*) Inundation Canals, which have no masonry regulators in the river for the purpose of regulating the supply to the canals. They only flow when the river is in flood.

(*ii*) Permanent Canals, which are designed on scientific lines with all the necessary works for control of supply.

The Inundation Canals are a relic of the olden days. They were dug by the cultivators on a co-operative basis and on common sense principles without the aid of any engineer. These canals have served a very useful purpose but they are being gradually replaced by permanent or weir controlled canals and very few of them are left at present. No description, therefore, need be given of these canals.

Modern Canals.

A permanent modern canal consists of :—

(*i*) Headworks at the point of offtake from the river ;

(*ii*) Main Canal and Branches ;

(*iii*) Distributaries and minors for distribution of Supply to the individual water courses which in their turn distribute water to the cultivator's fields.

The Headworks consists of :—

(*i*) a barrage or weir in the river to hold up and regulate the supply to the canal ;

(*ii*) a Head Regulator at the point where canal takes off, for regulating the supply ;

(*iii*) training works above the weir for keeping the river course in a desired channel.

Plate IX shows the lay-out of the Headworks of Lower Chenab Canal at Khanki and its various component works. This plan is typical of other headworks. Plate X gives a bird's eye-view of a typical canal system with its main canal branches, distributaries and minors. Each of them is clearly indicated. Water-courses for irrigation to individual fields are not shown. The total mileage of channels on a canal depends on the area commanded by it. On the average it is about 1,500 miles of Government channels and 5,000 miles of cultivators water-courses. The area irrigated by a canal in the Punjab on the average is about half a million acres.

There are 12 separate canal systems in actual working at present in the British Punjab, besides three systems of Inundation Canals. One more system, the Haveli Project, is in the course of construction. All the various systems are exhibited in distinct colours in Plate I.

The following table gives for the year 1935-36 the names of the various permanent canal systems with their capital cost, mileage of channels, area commanded, area irrigated annually, value of crops grown annually, and the yearly return on the capital cost :—

	Capacity and Head.	Capital Cost.	Mileage of Channels.	Area Irrigated.	Net Revenue.	Annual Return.	Value of Crops.
Western Jumna Canal ..	6,430	1,89.30,690	1,900	890,054	21,88,500	11·56	...
Sirhind Canal ..	9,040	2,63.55,471	1,624	1,220,105	35,97,725	13·65	...
Upper Bari Doab Canal .	6,750	2,16,63,608	1,504	1,266,671	43,91,845	20·27	..
Lower Chenab Canal ..	11,231	4,43,26,741	2,437	2,363,112	59,18,719	35 91	.
Lower Jhelum Canal ...	3,970	2,02,54,873	1,010	865,986	36,77,684	18·16	..
Upper Jhelum Canal ..	8,783	4,50,10,953	583	287,552	9,91,957	2·20	...
Upper Chenab Canal ...	14,400	3,77,58,165	1,249	299,312	16,20,072	4·29	...
Lower Bari Doab Canal ..	7,200	2,33,20,006	1,335	1,235,164	82,23,558	35·26	...
Eastern Canal, S. V. P. .			312	120,264			...
Depalpur Canal ...			918	385,476			
Pakpattan Canal .		9,22 31,373	1,089	559,743	1,19,214	0 87	
Mailsı Canal ...			616	284,150			

Western Jumna Canal.

The Western Jumna Canal was originally dug by Feroze Shah Tughlak about the middle of the 14th Century for his hunting grounds in Hissar. A Branch was later dug by Shah Jahan for the gardens in Delhi. Some irrigation of ordinary crops was done incidentally on the way. The entire system however, ceased working in the 18th Century owing to neglect. It was rejuvenated by the British Government early in the 19th Century, but the designs were more or less crude. The natural drainage lines of the country were obstructed with the result that land became soon waterlogged and the country became infested with malaria. The canal had therefore to be remodelled on modern lines towards the end of the 19th Century with a few extensions. This design is in use at present. The canal irrigates the districts of Karnal, Delhi, Rohtak and Hissar and the Indian States of Patiala and Jind.

Sirhind Canal.

The *Sirhind Canal* takes off from the Sutlej River at Rupar with a capacity at head of 9,040 cusecs. It was constructed in the years 1870—80 for irrigation of the area in the British districts of Ludhiana, Ferozepore and Hissar and the Indian States of Patiala, Nabha and Jind. These States contributed towards the capital cost of the canal in the proportion of the area to be irrigated in their respective territories and are therefore shareholders in the river water available for the canal. The shares of the various parties in the canal are :-

British	...	64 per cent.
Patiala	...	30·069 per cent.
Nabha	...	3·168 per cent.
Jind	.	2·736 per cent.

The small States of Malerkotla, Faridkot and Kalsia also receive water but they are not shareholders. The area irrigated on the canal is 1,220,105 acres at present.

Upper Bari Doab Canal.

The next canal is the *Bari Doab*, now called the Upper Bari Doab Canal owing to the construction of another canal lower down the same doab later on. This canal takes off from the River Ravi at Madhopur near Pathankot and has a capacity of 6,760 cusecs. It was constructed in its present form in the year 1860, and irrigates the districts of Gurdaspur, Amritsar and Lahore. The total area irrigated at present is 1,266,671 acres.

This canal is really an elaboration of the old Hasli Canal of Ali Mardan Khan, extended and improved according to modern scientific principles. Its construction in the early period of British annexation helped to settle down the disbanded Sikh soldiery of the Khalsa Army to the peaceful vocation of agriculture, a useful British policy, which has been applied with remarkable results in other similar conditions in this country

Lower Chenab Canal.

The Lower Chenab Canal takes off from the River Chenab at Khanki about 8 miles below Wazirabad. Whereas all the other canals already described dealt with the irrigation and development of previously populated tracts, in which some means of cultivation already existed, this canal was intended for the irrigation of a vast tract of land which had been lying waste and uninhabited for centuries, the only inhabitants being nomad camel graziers. The development of this area involved not only the design and construction of the necessary canal system, but also colonisation of the tract, which had neither any villages, nor any means of subsistence.

The designing of this novel canal took several years in surveys and investigation. It was begun in the year 1872 and the Project was sanctioned in 1890, *i. e.*, after 18 years. The canal at present has a full supply capacity of 11,231 cusecs at head, has 2,437 miles of Government irrigation channels and irrigates an area of more than 2 million acres.

This is the first canal in which the engineers had a free hand in designing the entire system not only of the canal, but of irrigation. The entire area of waste land was divided up into square fields with each side 1,100 feet long and having an area of about 28 acres. The division into fields of defined shape and area has helped considerably in administration and assessment and has distinct advantages over area with fields of all shapes and sizes which are to be found in old populated districts. The boundaries of villages were fixed with due regard to the boundaries of irrigation chacks and both were made coterminus as far as possible. The village sites were selected at suitable points where they would be free from flooding and easily accessible from all parts of the village land. The lay-out village houses and streets were fixed with due regard to sanitation and ventilation. The entire system of colonization was done by engineers on up-to-date scientific lines.

The system of water courses for distribution of water to individual fields on this canal and other colony canals constructed subsquently, is the best in the world. They all run straight along field boundaries and deliver water to each field at the most suitable point, which is the highest point in a field.

Owing to the scientific designing and the fertility of the soil, this colony has proved to be the richest tract in the whole of the Province. The increase in population has been phenomenal. Before irrigation started, *i.e.*, in 1891, the area had only 7 inhabitants to the square mile. In 1931, the last census, the density of population rose to 350. Most prosperous towns and markets have sprung up. Lyallpur, the headquarters of this colony, is one of the most flourishing and lively towns in the Province, carrying on extensive trade in all the agricultural products of the Colony. Mills and factories are gradually springing up and the town bids fair to be an important industrial centre.

Lower Jhelum Canal.

Lower Jhelum Canal is another colony canal, similar to the Lower Chenab Canal in design and conception though smaller in size. It takes off from the River Jhelum at a point called Rasool about 30 miles below Jhelum. The canal has a head capacity of 3,970 cusecs and irrigates the districts of Gujrat, Shahpur and Jhang. The irrigated area is at present about 9 lakhs acres.

Triple Canals Project.

The next three canals, *i. e.*, the Upper Jhelum, the Upper Chenab and the Lower Bari Doab constitute the well-known Triple Canal Project. The object of this project was to provide water for the irrigation of waste lands in the districts of Montgomery and Multan. No water was available in the Ravi River, it having been already extracted higher up for the Upper Bari Doab Canal, while that in the Sutlej was reserved for the irrigation of Nili Bar tract. The Upper Jhelum Canal was therefore dug across country from a place called Mangla to Khanki the head of Lower Chenab Canal, to carry surplus water of the Jhelum River to the Chenab River. An equivalent amount of water was taken out at a higher point in the Chenab River called Merala, and carried by the Upper Chenab Canal and delivered on the River Ravi at a point called Balloki. A canal was taken off on the left bank of the River Ravi at this point called the Lower Bari Doab Canal, for the irrigation of the waste land referred to above.

Both the Upper Jhelum and Upper Chenab Canals while carrying water from one river to the other across the country do large amount of irrigation in the area through which they pass. This interlinked canal system is clearly exhibited in the Map on Plate I

The capacities of the three canals and the area irrigated by them are given on page 133.

Sutlej Valley Project

The remaining four canals, *i.e.*, the Eastern, the Dipalpur, the Pakpattan, and the Mailsi Canals constitute the British portion of the great Sutlej Valley project. Besides these canals, this system comprises the canals for Bikaner and Bahawalpur States. The Project consists of four weirs or barrages across the River Sutlej at Ferozepore, Sulemanke, Islam and Panjnad with 11 canals perennial and non-perennial taking off above them for irrigation of the area on both sides of the river. The total capacity of the canals is 13,000 cusecs in winter and 40,000 cusecs in summer The total area proposed to be irrigated is about 5 million acres and the total mileage of channels in British territory only about 3000. The construction of this project was started in 1922 and completed in 1930. The total cost of the work is 24 crores which was shared by the British Government and the Indian States of Bikaner and Bahawalpur in the proportion of the water allotted to each.

This gigantic project has conferred incalculable benefits on the area previously irrigated from the Inundation Canals by giving them a more certain weir controlled supply thus rendering such areas free from the vagaries of the river Secondly, it has brought large areas of waste land in the uplands under cultivation. The famous Nili Bar is the most important of such areas. The States of Bikaner and Bahawalpur are well-known for their sandy deserts which could not grow a single blade of grass. This project has converted vast tracts of these States into green fields flowing with milk and honey. The sale of waste land alone brought into the coffers of the two States crores of rupees, while the yearly revenue is more than one crore (10 million).

The engineering design of this project presented innumerable difficulties. The surveys and investigations and the conclusion of the partnership agreement with the States alone took nearly 15 years. The design and construction marked the latest ideas on the subject as developed by past experience and research in this and other countries.

The general map (Plate I) shows the positions of the weirs in the river and the off-taking canals

This finishes a description of all the important canal systems in the Province. The only other canals are the Inundation Canals, which, though fulfilling a real necessity for the local areas served by them are small in size and possess no interesting engineering or other special features. They are a relic of the pre-science period and there is no need to describe them in detail.

Haveli Project.

The map of the Punjab shows in pink the areas for which new schemes for irrigation are either under execution or in contemplation. The scheme actually under execution at present and likely to be a *fait accompli* in a few months is the Haveli Project. This scheme is designed to replace the Inundation Canals, in the Multan district by a weir controlled canal, which will take off from the River Chenab below its junction with the Jhelum river. After passing across country in Jhang district for a distance of about 45 miles, it discharges into River Ravi at a place called Sidhnai. From here three canals take off which will replace the existing Inundation Canals taking off from the Ravi and Chenab. In addition to improving the existing irrigation, the scheme provides for irrigation of acres of waste area. The capacity of the canal at head will be 2,750 cusecs and the new area to be brought under cultivation will be (?) acres. As will be seen from the map, the Chenab and Jhelum rivers are fully tapped in winter at Khanki and Rasool by the canals taking off at these points so that no water goes down the river in the winter months. The Haveli Canal during these months will be entirely dependent on the percolation that takes place from the surrounding irrigated country into the rivers in the reaches below the upper weirs. It has been estimated that this percolation will be more than 1,000 cusecs in these months.

Thal Project.

The next scheme to be taken up is the Thal Project for irrigation of the sandy tract lying between Jhelum and Indus rivers as shown on the sketch map. The canal will take off from Indus river at Kalabagh near Mianwali, where a weir or barrage will be put up in the river Owing to the canals in Sind being dependent entirely on the water in Indus river, their pre-emptory right on the use of the waters of this river has been recognised by the Government of India and the Punjab has been permitted to draw only the surplus water for the Thal Canal. This quantity has been fixed by the Government of India at 6,000 cusecs, which will be sufficient for the irrigation of 12,00,000 acres being only a fraction of the total Thal area. Even so, the irrigation will prove a great boon for the inhabitants of this tract who carry a very precarious cultivation at present. This project has been under investigation now for the last 30 years but there is very likelihood of its being taken up within the next two years.

Bhakra Dam

The schemes already described exhaust the entire winter supplies of all the rivers in the Province, but there are still areas clamouring for water, particularly in the arid tract lying between Sutlej and Jumna, in the districts of Hissar and Rohtak. There are only two methods of supplying water to this tract, *i. e.*, either by pumping from the subsoil by means of tube-wells or by storing the surplus supplies that are available in the rivers in summer by means of storage dams in the hills such as the proposed Bhakra Dam, and releasing this stored supply in winter. Both these schemes are at present under serious investigation. There are innumerable difficulties, engineering, political and administrative, but it is hoped that the genius of Punjab engineers will be able to find a solution. The tract is subject to famine in years of drought and is a blot on the fair name of the Punjab. There is no water even for drinking and the rain water stored in village ponds is used both by human beings and cattle. The inhabitants carry on a very precarious existence and there is extreme poverty.

Canal Colonies.

No description of the canals in the Punjab would be complete without mention of the splendid colonies that have sprung up in areas which were previously desolate wastes growing practically nothing but grazing for camels, and inhabited by nomad tribes whose only means of subsistence was the camel's milk and such precarious cultivation as they could carry on with the help of rain. In his book "Wealth and Welfare of the Punjab" Mr. H. Calvert writes: "The great colonies made possible by these huge (canal) works are the creation of forty years co-operation between the most skilled body of water engineers in the world, constructive administrators of various services and the hardy and industrious peasant of the Punjab. They enjoy a prosperity such as none of the older settled districts can match and they bear witness to the high standard of perfection both of the irrigation system and of the schemes of colonization. As Lord Curzon remarked they have converted the Province from a battlefield of frontier warfare into a home of contented and peaceful peasantry."

There are altogether nine colonies, but only four are really large and important, *i. e.*, Lower Chenab Canal (Lyallpur) 4,000 square miles in extent, Lower Bari Doab (Montgomery) 2,250 square miles, Nili Bar (Pakpattan) 1,500 square miles and Lower Jhelum (Sargodha) 700 square miles. The remaining five vary in size from 100 to 350 square miles. All are fully developed except the Nili Bar of the Sutlej Valley Project, of which the development has been to some extent retarded owing to recent fall in the prices of agricultural produce. Collectively these colonies constitute an area of about 6 million acres, which means an accession of enormous wealth to the Province. The Lyallpur colony is by far the most prosperous and the canal irrigating it is the most remunerative work ever built anywhere. The area irrigated annually by this single canal is about 24 lakh acres and the value of crops raised about Rs. 36 lakh. The capital expenditure on the canal is 443 lakhs, while the percentage return on this outlay for the last 10 years averages about 40 per cent The highest was 54·04 per cent in 1925-26. There is still about 1,50,000 acres of waste area of slightly inferior land waiting to be colonised, as soon as more water can be arranged for. Several schemes for providing this additional supply are at present under investigation. When this area is also developed, there will be further increase in the prosperity of this colony.

Distribution of Water.

The distribution of available water supply constitutes a very difficult and complicated affair. This may be considered under three heads:—

(*i*) Distribution of river supplies when there is more than one canal dependent on the same river and the supply in the river is insufficient to meet the requirements of all the canals at the same time.

(*ii*) Distribution of water within each canal system itself, when the supply available at head is less than the total of the supplies required by its various branches

(*iii*) Distribution of water on an outlet among the various cultivators whose lands have been designed to be irrigated from that outlet.

Distribution of *river* supplies has to be done in the case of 5 linked canals relating to the Triple Project, which depend on the rivers, and in the case of all the canals of the Sutlej Valley Project which depend on one river only. The total discharge of the 5 linked canals (Upper Jhelum, Lower Jhelum, Upper Chenab, Lower Chenab and Lower Bari Doab) is 24,400 cusecs, while the total average supply available in winter in the two rivers is 13,000 cusecs, so that each canal can run only about half the time. Similarly the total winter discharge of the Sutlej Valley Canal is 13,000 cusecs, while the average supply of Sutlej River is *only about 5,000 cusecs. This distribution is attended with numerous difficulties, as the crops on all the* canals require *water for sowing or maturing practically at the same time. The distribution has therefore to be done in units of small periods of say 12 days each so that* each canal may *have* a fair chance of obtaining supplies in the various crop periods. This is naturally unpopular with the cultivators, but no better solution has been found. There are similar other technical difficulties which need not be detailed here.

Distribution within the canal system itself when the supply available at head is not sufficient to feed all its branches at the same time is not as complicated as the distribution of insufficient river supplies among the canals. The distribution is done proportionately to the irrigable area on each channel as far as possible. Each canal system being in the administrative charge of one officer and the area being limited with a more or less uniform demand the distribution allows of a certain amount of elasticity which is not permissible in the *other case.*

Distribution of water on an outlet among the shareholders dependent on it is not a difficult problem, but it is very troublesome. Legally this distribution is left to the shareholders themselves and Government officials are forbidden to interfere unless a complaint is made to them. In practice, however, the turns of the various shareholders are always fixed by Government in proportion to the area of each shareholder. When a dispute arises, this is decided by Law Courts. These disputes are very common and the poor are invariably the sufferers. They are a chronic source of worry and expense to all concerned, but it is impossible to stop them until such time as a spirit of co-operation, fair play and regard for the rights of others grows up among the people.

Charges for Canal Water.

The system of charging for water used by each cultivator is elaborate but simple. Each field receiving canal water is measured up individually and entered up in a register together with the name of the cultivator and the crop sown. At the end of the season all the fields irrigated by a cultivator are entered in a demand statement or bill form, on which are also shown the area under each kind of crop with the rate at which the various crops are assessed. This rate is in accordance with a schedule which is fixed for each canal system separately, though the variations between one canal and another are not very appreciable This method of assessment was adopted when the canal irrigation was first introduced. It requires a huge establishment of petty revenue officials, who practise constant petty tyrannies on the ignorant cultivators, in spite of strict vigilance on the part of superior officers. The method is essentially crude and there has always been a keen desire on the part of the engineers to change this method for one of charging by the volume of water taken by each cultivator. There have, however, been several obstacles in the way of the desired change, the principal one being the lack of co-operative spirit among the cultivators. Under the present conditions it is quite hopeless to expect them to distribute the water received equitably among themselves. In spite of the fact that this distribution is at present arranged by Government, disputes are frequent, sometimes resulting in murders. The growth of the co-operative movement among the rural population that has taken place during recent years is likely to help the irrigation Engineers in bringing the methods of distribution on more scientific basis. Further it will reduce opportunities of corruption, introduce economy in the application of water by the cultivators and appreciably decrease the cost of administration.

From what has been written above, it will be readily seen that the canals constitute the very life of a great proportion of people in the Punjab. They are the only means of sustenance for the major portion of the country. In some tracts they provide even the water required for drinking purposes, due to the well water being brackish and unfit for drinking. It is thus a matter of vital necessity to maintain them in an efficient working order ; any deterioration in their efficiency will seriously affect the economic condition of the cultivators.

Administration of the Canals.

Besides the work involved in the distribution of the available river supplies and the assessment of area irrigated, the maintenance of a canal presents several intricate problems which require constant watch and study on the part of the engineers incharge. On their solution and the prompt application of the remedy depends the efficient working of the canals. For proper supervision, control and direction of the huge system there are three Chief Engineers, 12 Superintending Engineers, 50 Executive Engineers and a large number of Assistant and Subordinate Engineers together with the necessary staff of revenue officials for assessment purposes. Each separate canal system generally constitutes a Superintending Engineer's charge. He is responsible for its efficient working, its revenue and its expenditure. In addition to this staff in direct charge of the working of the system, a big Research Station is maintained at Lahore under the control of a Director (a chemist) assisted by about half a dozen Research Assistants each in charge of the various sections. such as Hydraulics, Physics, Chemical, Soil, Mathematical, etc. This Research Station has done very useful work, especially in the Hydraulic Section, as it helps the engineer to test out his designs before actually accepting them for execution. It is the best equipped and best staffed station in India, in fact there is none of its kind in any other Province.

Design of Irrigation Works.

The design of irrigation channels and works requires complicated calculations and consideration of numerous local factors. Owing to the vast extent of these works carried out in the Punjab and the multifarious conditions the designs are required to satisfy and also owing to the existence of a Research Institute, the Province easily leads the way in the world as far as the design and magnitude of the canals and their component works are concerned. The Upper Chenab Canal with a discharge of 14,400 cusecs is about the biggest irrigation canal in the world.

It is in this Province that the most satisfactory formulæ for the design of channels with a non-silting and non-scouring velocity were first devised by the

PLATE NO II

MAP OF PUNJAB PROVINCE
SHOWING
AREA UNDER IRRIGATION IN 1865
SCALE 1 : 80 MILES

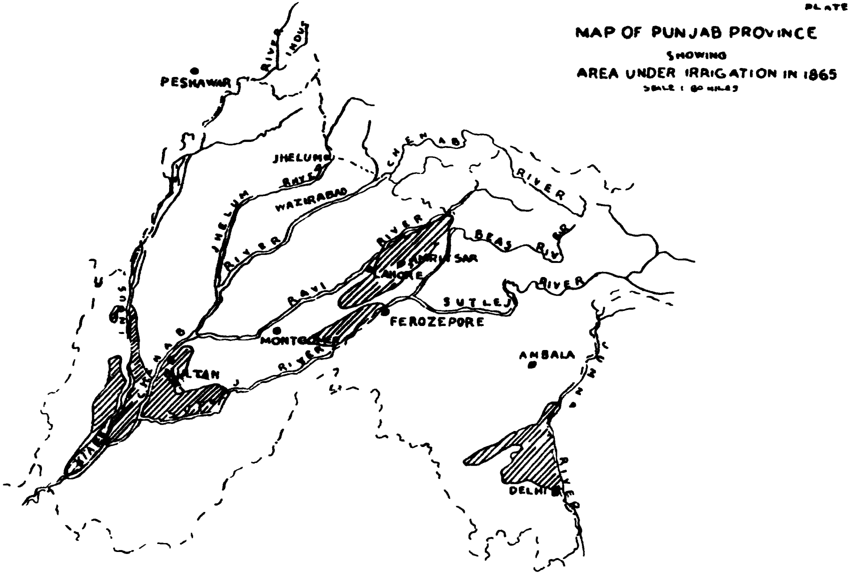
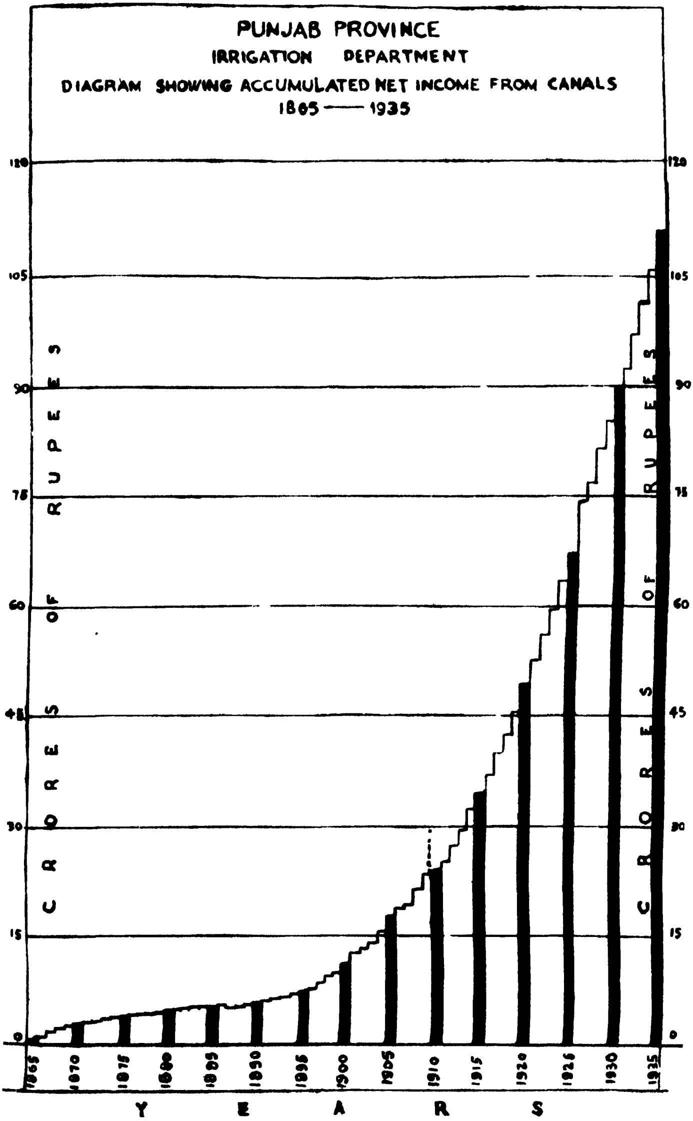


PLATE III



PUNJAB PROVINCE

IRRIGATION DEPARTMENT

DIAGRAM SHOWING ACCUMULATED NET INCOME FROM CANALS

1865 —— 1935

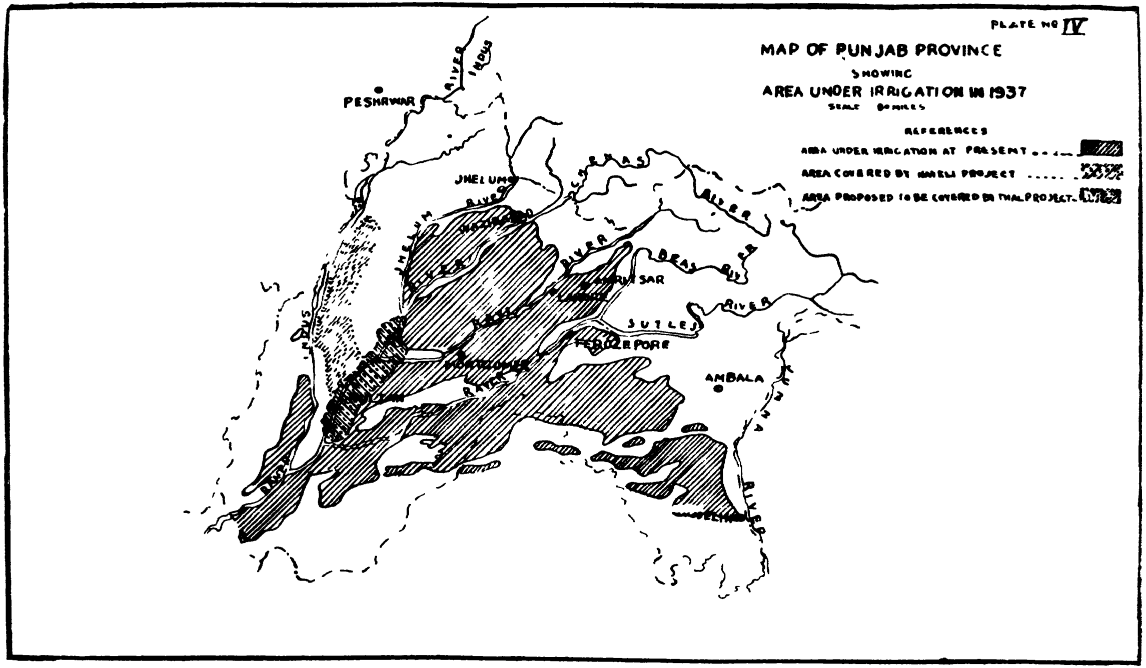


PLATE NO IV

MAP OF PUNJAB PROVINCE

SHOWING

AREA UNDER IRRIGATION IN 1937

SCALE ... MILES

PLATE-V

DIAGRAM SHOWING
RISE IN POPULATION AND IRRIGATION
IN THE PUNJAB
1885—1935

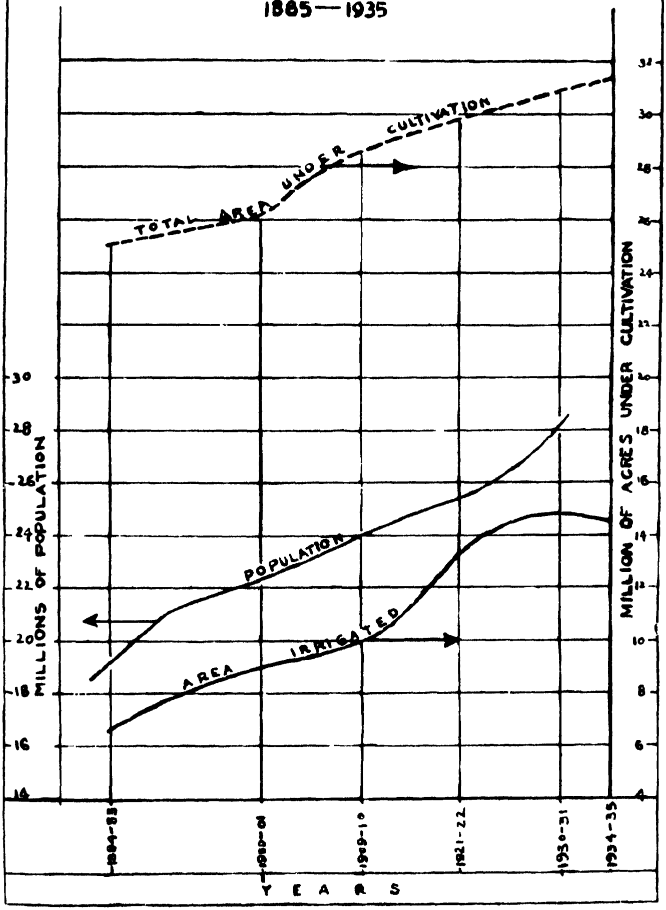


PLATE-VI

PUNJAB PROVINCE

DIAGRAM SHOWING CAPITAL OUTLAY ON CANALS
1865-1935

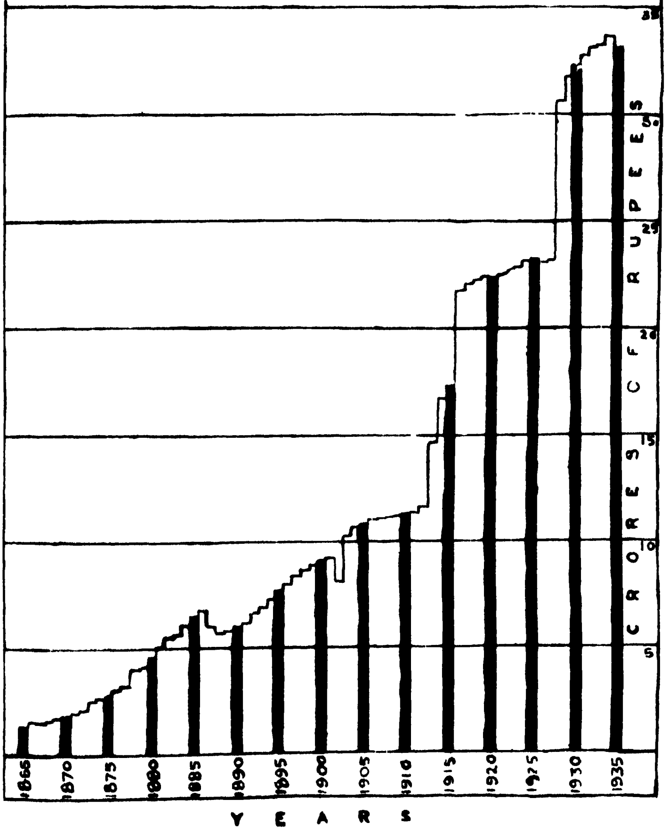
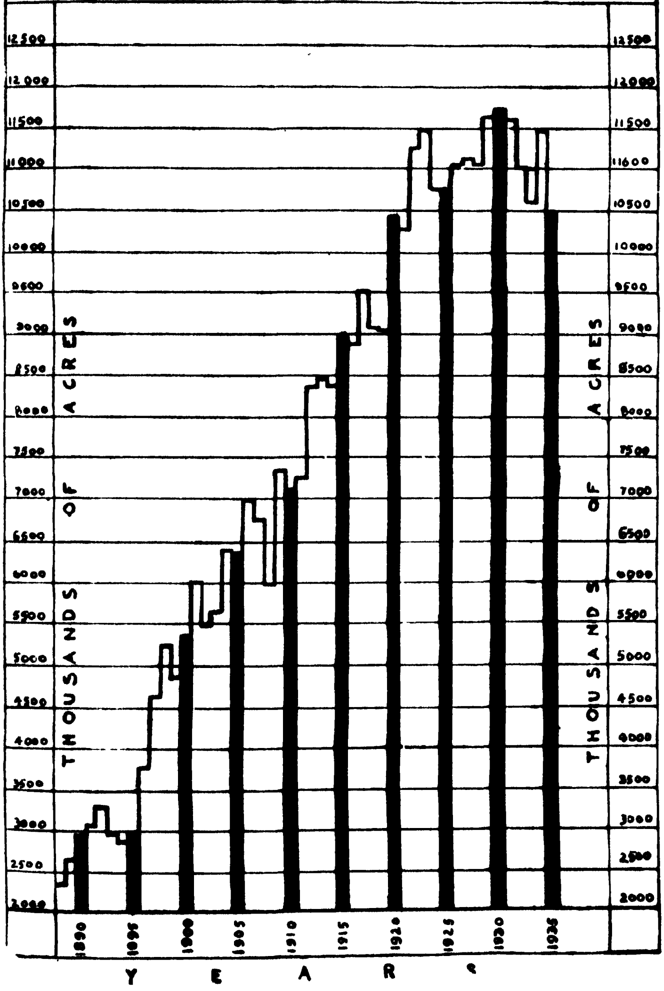


PLATE VII

PUNJAB PROVINCE

DIAGRAM SHOWING PROGRESS OF IRRIGATION FROM CANALS
1888 — 1935



PUNJAB PROVINCE

PLATE Nº ·

ESTIMATED VALUE OF CROPS RAISED ON CANAL IRRIGATED AREA
1888 — 1935

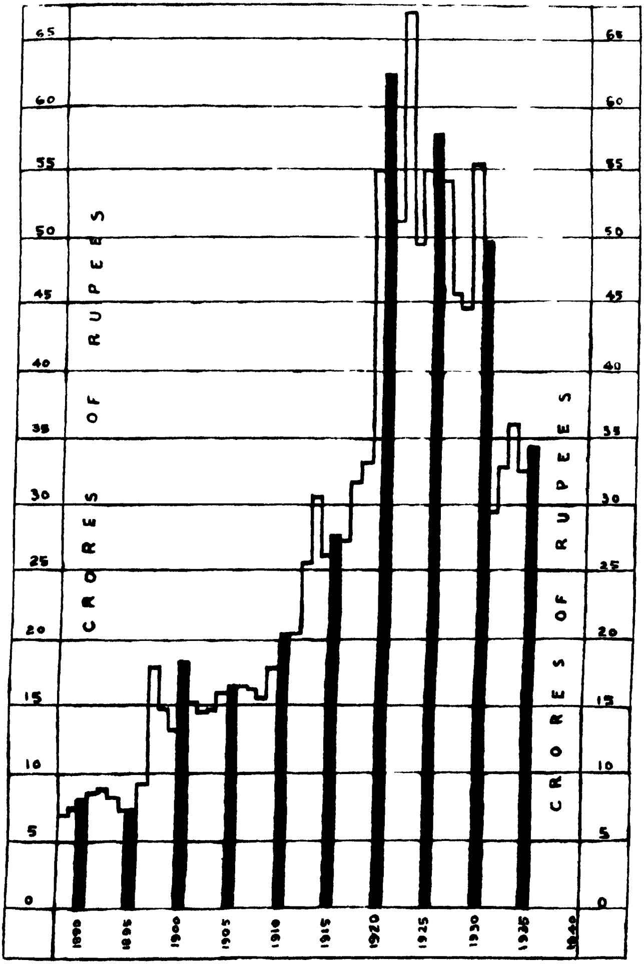


PLATE IX

PLAN SHOWING
HEADWORKS & TRAININGWORKS
LOWER CHENAB CANAL
AT
KHANKI

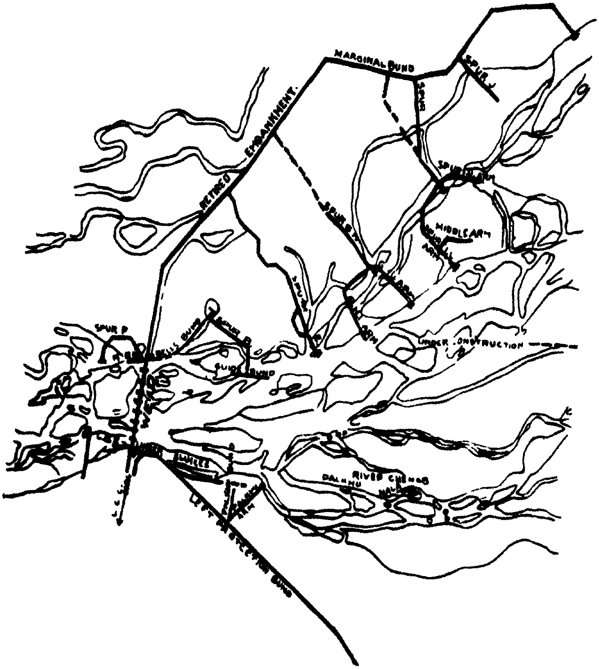
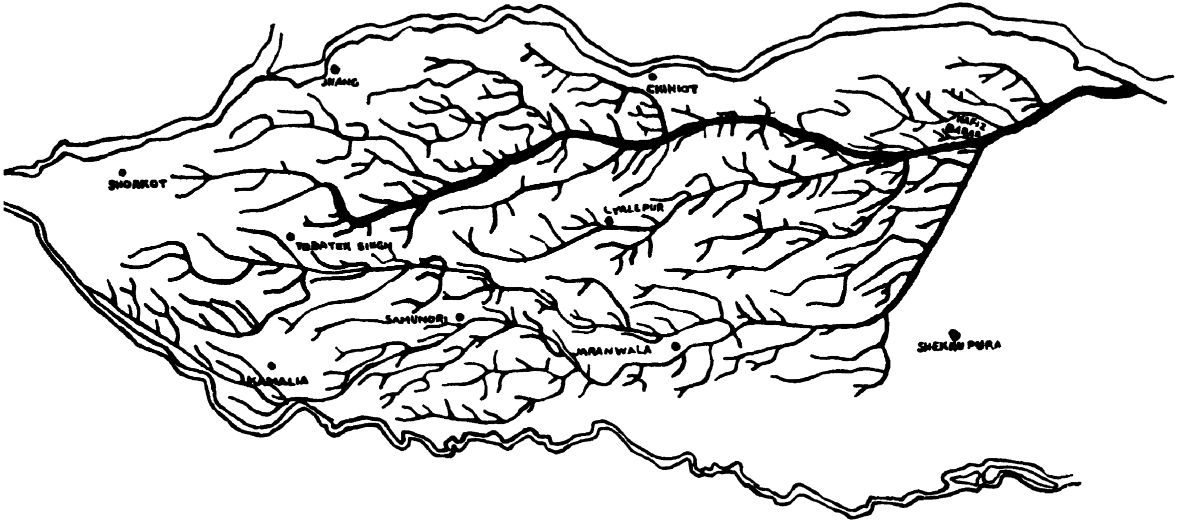


PLATE X

LOWER CHENAB CANAL



late Mr. R. G. Kennedy. The diagrams prepared by him on the basis of these formulæ are being universally used by the profession. It is in this Province that the most effective devices have been designed for preventing coarse river silt from entering the canals The unrestricted entry of this silt would soon choke up the channels and render their working quite impossible. Again it is here that the best designs have been evolved for weirs and barrages in the river for the control of river supply.

Waterlogging of land by rise of spring level is one of the evils attending any canal system constructed in alluvial soil. It is in the Punjab that this problem has received the greatest attention and undergone most intensive research. Though no satisfactory solution has yet been found, a great advance has been made. It is hoped it will not be long before the joint efforts of engineers and scientists will find a solution, which would be easily workable.

CHAPTER IX

AGRICULTURE IN THE PUNJAB.

BY

M. AFZAL HUSAIN, M.A., I.A.S.

Agriculture is the main industry of the Punjab. Of the 26 million people of this Province approximately 20 million live in 35,000 villages. The population in towns is only 17 per cent. of the total population. The pressure on land is very great and so far industrialization has been very slow.

This land of five rivers has been correctly described as the land of peasant proprietors. It has been estimated that 18 per cent. of the owners of the cultivated land in the Province own less than 1 acre ; about 40 per cent. of them own less than 5 acres; and 26 per cent. less than 15 acres. The proportion of land owned by the peasant proprietors of these categories is 3 per cent. of the total area. Those who own an area, which is from 15 acres to less than 50 acres are 11·8 per cent. and the land they possess forms approximately 36 per cent. of the whole area. Those, who own 50 acres and over are only 3·7 per cent. of the owners of land and the total area under them is roughly 26 per cent.

It may be claimed that the Punjab peasant has a better physique and a higher standard of living than the peasants in other parts of India. It is also true that the Punjab is not as over-populated as some other Provinces. Nevertheless the present economic position of the farmer is a matter of deep concern.

The rural debt of the Punjab has been estimated at rupees 135 to 145 crores. The debt per cultivated acre is Rs. 45 and the debt per head of those supported by Agriculture Rs. 104. The holdings are small and many of them are uneconomic The difficulties of climate, impoverishment of soil through continued cropping without adequate manuring, inadequate and uncertain natural water-supply, low prices of agricultural commodities, subsistent nature of farming and absence of cottage industries added to the economic position of the farmer, make agriculture an unremunerative profession. To provide financial aid to the zamindars, Co-operative Societies have been started. Efforts have been made to consolidate holdings. Irrigation facilities are provided and recently various legislative measures to protect the zamindars have been enacted. A Marketing Bill is before the Legislative Assembly. Through research better type of crops have been made available and better methods of cultivation initiated.

In what follows an attempt has been made to present a picture of this industry and the efforts made towards its amelioration.

The Punjab is situated in the north temperate zone—the home of the chief cereals and the most important domestic animals. It has an inland position and is at a considerable distance from the sea: Lahore being 750 miles from Karachi, the nearest sea port

Climate.

Bounded on the north by the highest mountain of the world—the Himalayas—with their permanently snow clad peaks, and extending to Rajputana, the driest part of India, to the south, and because of its inland position, the Punjab has a contrasting climate, very hot in summer and very cold in winter. In summer the maximum in shade may, in certain parts reach 120° F. and during winter the temperature may fall to 29°F. Such extremes of climate have produced a hardy and martial race, vigorous in body and mind, and a soil which possesses a vast range of variation, from perpetual snow to desert conditions, providing scope for crops and fruit trees of all types.

During winter there is in-draught of cold winds from the dry and waterless regions in the north-east and north-west causing dry chill. Thus during December and January, and occasionally November and February as well, frost occurs during the major portion of the Province. Failure of winter rains increases the intensity of frost to such an extent that the standing crops especially sugarcane, potatoes, vegetables and fruits—particularly citrus and mangoes, suffer greatly

The Punjab gets 'winter rains' in the months of December and January, when winds laden with water vapours come from the Persian Gulf and on meeting the Hindukush and other mountain ranges cause precipitation. This rain is of considerable importance in mitigating the effect of frost and providing soil moisture for the standing *rabi* crops. Failure of 'winter rain' has a disastrous effect on the standing *rabi* crops especially in the purely rain-fed areas. Good winter rains mean a bumper *rabi* harvest. Unfortunately, sometimes hailstorms cause considerable damage in certain localities. Excessive cloudy weather and presence of moisture in the atmosphere during the period January to March may damage the crops by providing conditions suitable for the development of fungal diseases such as rust, bunt, etc. Cloudy and unsettled weather also interferes with the activity of bees which pollinate the cruciferous oil seeds.

The spring which may extend over two months—middle of February to middle of April, is followed by a very intense summer. The heat begins to be unpleasant in April and hot winds begin to blow from the south. Wind storms are usual during this period accompanied by occasional thunder and hail storms. They relieve the strain of heat for a while. From the close of April right up to the summer solstice (June 22nd) or a week or two later, is the hottest time of the year. It is extremely dry and very trying for the standing *kharif* crops. The maximum temperature ranges between 110° to 120°F in the plains of the Punjab and sometimes even jumps higher.

The monsoon starts from about July. The sea wind which blows from the south-west—the Arabian sea—the so-called "Bombay current" sweeps over the Western Ghats, it spreads over the Peninsula, Central India, Rajputana and North Bombay, and blowing over Gujarat, Kathiawar and Sind gives a certain amount of rain to western Rajputana and passing onward gives moderate to heavy rain in the eastern Punjab and north-western Himalayas. In this region this current meets the monsoon current from the Bay of Bengal—the "Bengal current" which sweeps over Bengal and Assam and meeting the barrier of the Himalayas is deflected westward and gives general rain over the Gangetic plain and over the Punjab decreasing in its intensity as it travels west. Though the hill regions get copious and the submontane regions ample rain, the amount which reaches the Central Punjab and especially the western half of the Province is quite inadequate for raising crops. The average rainfall of the west of the Punjab is five inches.

Between the "Bengal current" and the "Bombay current" there exists the "dead" area of Sindh and Rajputana and the bordering areas of the west and south-west of the Punjab, and south-east. This area, particularly the district of Hissar is in the throes of a terrible famine this year (1938).

It is only when both the "Bombay" and "Bengal" currents meet that we get widespread rain throughout the Province. This enables the *kharif* crops to flourish and there are bright prospects for the *rabi* crops to follow.

Slight showers of rain may come as early as the middle of June, but there is always a considerable gap before the actual rainy season sets in, the normal time being the last week of June or first week of July. The rainy season closes about the second week of September.

Main Divisions.

In the mountainous regions in the north and north-east the rainfall is very heavy—60 inches and over—and on account of abrupt slope most of this downpour takes the form of run off water and forms hill torrents, which cause soil erosion, on a very large scale, in the area at the foot of these hills, and this is one of the major problems facing the Province. The soil is stony and is often terraced with great labour. On irrigated land rice is grown and wheat, maize pulses are the common crops. Some areas such as the Kulu valley, Kotgarh, Simla Hills, grow excellent fruit. Most farmers supplement their income by sheep and goat breeding. Honey-bees are kept by some.

The *pothwar* plateau lies between the Indus and Jhelum rivers to the north of the salt range. It is an upland country, the general height of which ranges between 1,000 to 2,000 feet above sea level. Ravine-bitten and seamed with sandy beds of torrents, it is an arid and precarious tract with fertile stretches here and there. The area comprises the districts of Campbellpur, Jhelum and Rawalpindi—important districts which provide recruits for the Indian Army. Practically the whole of the soil of this upland plain consists of disintegrated sand stones from the Siwalik hills and therefore these soils differ widely in general appearance and fertility from the alluvium of the rest of the Punjab. There is no canal irrigation and well irrigation is expensive on account of great depth of spring level, except in low lands bordering on rivers. Chach is one of such localities where intensive cultivation is carried on and tobacco grown under well irrigation.

To the south of this upland country is situated the salt range. It contains geological records of three distinct eras -Cambrian, Carboniferous and Tertiary, and is one of the richest fossil bearing zones. The Khewra salt mines are situated here.

The alluvial plains of the Punjab which constitute the greater part of the Province are situated between the rivers of Jhelum and Jumna. Except for a few hillocks near Delhi and Hissar in the south-east, and at Kirana, Chiniot and Sangla, the entire plain has a perfect level with a gentle slope towards the south-west. The great plain is a deep alluvium of a considerable depth varying in its physical constituents from almost pure coarse sand to fine clay, the proportion of clay varying from 5 per cent. to 90 per cent. It can be divided into the following main divisions with regard to climate and cropping :—

(a) *The submontane tract.*—It has an annual rainfall of 30-40 inches, five-seventh of which is received during the monsoon season. This is supplemented by well irrigation. The soil is fertile and crops moderately secure. Therefore the population in these areas is densest in the Province, upto 500 and over per square mile. Wheat, maize, sugarcane, gram and *jowar* are grown. Mangoes flourish and citrus fruits do well.

(b) *The central plain.*—It is very cold in winter and fairly hot in summer. The rainfall in this tract is between 20 to 30 inches per annum. All kinds of crops can be grown.

(c) *The south-eastern Punjab.*— It has an annual rainfall of 15-20 inches. The extreme south-east is very dry and gets very little monsoon rain and is the most insecure part of the Province. The soil is light and the crops are such as suit the arid regions. Barley, gram, *bajra* and *jowar* are largely grown.

(*d*) *The western and south-western Punjab.*—It has an annual rainfall ranging from 5 to 15 inches. Extreme south-west gets less than 5 inches and has a desert climate, which is very dry and the soil is generally of light nature The western part of this tract is absolutely sandy in nature and the natural vegetation consists of thorny bushes scattered here and there.

Irrigation.

Because of its inland position and being out of the direct route of the main monsoon winds, a considerable portion of the Punjab does not receive enough rain for successful and certain maturation of crops. Further five-seventh of whatever rain is received, comes in heavy downpour during the monsoon, runs off and is wasted. The winter rains which are so essential for the success of the *rabi* crops are uncertain and often inadequate. In the circumstances farming in the rain fed areas of the Province is highly precarious. The Province has, therefore, developed artificial means of irrigation and to-day approximately 50 per cent of the cultivated area is irrigated either by wells or canals. The Punjab is fortunate in having many rivers flowing through it. The Indus flows down on its western side, while the Jhelum, Chanab, Ravi, Sutlej and Beas run in a south-westerly direction through the Province. The Jumna flows down the south-eastern side.

This land of five rivers with two more rivers supplementing its water resources has developed the biggest irrigation system in the world. During the first thirty years of the present century the canal irrigated area more than doubled and further extensions of irrigations are under contemplation. This subject is fully dealt with in the chapter on Punjab canals.

The number of wells used for irrigation is 332,182. In certain tracts such as Jullundur and Hoshiarpur the water-table has fallen greatly and is steadily falling further. The Engineering Section of the Punjab Department of Agriculture has designed various types of strainers to augment the supply of well water by boring. There are in the Punjab to-day about 9 thousand wells which have been thus improved. Besides these, tube-wells have been installed for irrigation purposes and to-day over 200 power-operated tube-wells, capable of delivering from a few thousand upto twenty-five thousand gallons per hour, are working. Further schemes of tube-well irrigation are in hand.

Water-Logging.

Since the introduction of canal irrigation there has been considerable rise in level of sub-soil water-table in certain portions of the Punjab. Following in the wake of the rise of water-table has been the accumulation of sodium salts in the surface soil. The problem is a serious one and is engaging the attention of the Irrigation Branch of the Punjab Government through a special water-logging department. The scientific aspects of the problem are being studied by the Irrigation Research Institute. This Institute has already made important contributions to the factors responsible for the movement of moisture and salts in soils ; the rise of water-table with reference to the nature of soils profiles : and methods of preventing seepage losses from canals. The main cause of the rise of water-table appears to be the lack of drainage channels capable of dealing with the monsoon rainfall. To cope with the monsoon rainfall the Government has decided to develop the drainage system of the country, and a five-year scheme has been evolved.

Some Soil Problems of the Punjab.

One of the most characteristic features of some of the Punjab soils is their tendency to develop salinity. Although records are scanty, it appears that certain areas have gone out of cultivation mainly due to this cause. The trouble usually appears suddenly and within a short period the land affected is abandoned on account of the crop yield becoming so low that it is not economical to continue cultivation.

The land affected by salinity, known locally as *thur*, generally shows white patches when the salt present is mainly sodium sulphate. Other important salts generally present, but which do not appear as white efflorescence are sodium chloride and sodium carbonate. The most effective remedy for the so-called saline soils is leaching with water followed by crops like rice and berseem.

Another important characteristic of the Punjab soils is the presence of replaceable sodium in the clay complex giving rise to alkalinity of varying degree. These so-called alkali soils locally known as *bara* present a problem of great difficulty to the agriculturist. Physically they are hard impervious to water and thus unable to support plant life. Some success has been achieved in the reclamation of such soils by the use of gypsum or calcium chloride which have a flocculating effect on the soil colloids Proper use of these chemicals results in the replacement of exchangeable sodium by calcium and if the treatment is followed up by growing rice and berseem, the land is fully reclaimed in 3 to 5 years depending on the intensity of alkalinity.

Area and Crops.

The Distribution of the area of the Punjab is as follows :—

	Area in Acres.
Forests	... 1,972,819
Not available for cultivation	... 12,862,158
Cultural waste	... 14,203,373
Current fallow	... 2,450.469
Net area sown	... 28,682,946
Total	... 60,171,765

The total area sown during the quinquennium ending with 1935-36 was as below :—

	Irrigated.		Unirrigated		Total.	
	Acres.	%	Acres.	%	Acres	%
Kharif crops .	5,877,515	18·8	7,612,475	24·1	13,289,995	42·0
Rabi crops	9,058,528	28·6	9,299,932	29·4	18,358,423	58·0
Total area sown ...	14,736,003	46·6	16,912,414	53·4	31,648,418	100·0
Area sown more than once ...	263,872	0·8	22,391	0·1	286,263	0·9
Total crops matured	13,719,546	43·4	12,411,214	39·3	26,130,761	82·6
Crops failed ...	1,016,457	3·2	4,501,199	14·2	5 517,657	17·4

Thus about 16 per cent. more area is sown during *rabi* than during the *kharif*. The quinquennial average for the same period shows that 82·6 per cent. of the total area matures annually and 17·4 per cent. fails and of this the percentage irrigated and unirrigated is 3·2 and 14·2 respectively. The food crops occupy 73·6 per cent. and the non-food crops 26·4 per cent. of the total area sown. Of the food crop, the area under *rabi* cereals is 31 per cent. as compared to 19·5 per cent. under *kharif* cereals. Of the pulses, gram occupies 15·4 per cent. of the total area under food crops and during certain years the prices of gram have been higher than the prices for wheat.

Area under food crops during the quinquennium ending with 1935-36.

Crops.	Area (Acres)	Percentage of the total area.
Wheat	9,156,291	28·9
Bajra ...	3,210,552	10·1
Maize	1,064,311	3·4
Jowar ...	933,224	3·0
Rice	927,954	2·9
Barley	646,736	2·1
Ragi ...	17,993	0·1
Other Cereals	169,064	0·5
Gram	4,871,221	15·4
Mung and *Mash*	513,320	1·6
Other Pulses ...	765,454	2·4
Sugarcane ...	487,088	1·5
Orchard & Garden Produce	258,856	0·8
Condiment and Spices	55,423	0·2
Miscellaneous	255,565	0·7

The fodders—food for cattle and horses, etc.—occupy 15 per cent. of the total area sown. Thus the crops which provide food either for human beings or cattle occupy 88·6 per cent. of total area and it is only 11·4 per cent. of the area which produces crops which may be regarded as cash crops. Agriculture under such conditions cannot but be a means of subsistence and the purchasing capacity of the farmers, therefore, is very low.

Of the non-food crops (excluding fodders) the following are the figures for area (quinquennial average ending with 1935-36) :—

Crops.	Acres.	Percentage of the total area.
Rape seed	505,717	1·6
Toria	451,223	1·4
Til	117,252	0·4
Linseed	29,148	0·1
Cotton, *Desi*	1,430,855	4·5
Cotton, American	898,919	2·9
Hemp	44,407	0·1
Tobacco	73,098	0·2
Narcotics	12,342	0·1
Dye crops	17,852	0·1

Wheat.

Wheat is the most important crop for the Punjab farmer. It is a comparatively hardy crop and can withstand climatic inclemencies and shortage of water better than cotton and sugarcane It can be grown in practically every part of the Province. The greater portion of the produce is required for consumption as it is the main article of diet of the people. Thus it is only partially a cash crop. The total area under wheat in India is about 32 million acres of which the Punjab has about 10 million acres—34 per cent. Of this about 5 million acres is irrigated and the rest is *barani.* The average yield of wheat in the canal colonies is about 16 maunds per acre. In the *barani* area it is only 7 maunds The general average for the Province is about 10-11 maunds.

The Agricultural Department made selection of wheat varieties out of the existing stock in 1908-9. The Punjab type 11 and type 17 were found to be the best. These pure types gave about 1-2 maunds more yield than the existing mixtures grown by the farmers. 8-A wheat was evolved by D. Milne. It is a general-purpose wheat and can be sown on all kinds of soils. It has been called the premier wheat of the Punjab, and has spread beyond the limits of the Province. Ramdhan Singh has placed in the hands of the growers a few improved types. The superiority of a new wheat C-591—a cross—over 8-A is so well established that the Department had to purchase large supplies of this type to meet the demand for its seed. Extensive trials have shown that on such soils which give about 20 maunds or more of wheat, C-591 gives at least 1 maund more than 8-A. Even in poor soils the cross out yields 8-A. C-591 as a late sown irrigated wheat has out yielded both 8-A and 9-D by 2-4 maunds per acre. As regards milling and baking qualities, the cross is superior to perhaps any other wheat grown in India and fetches a premium of about three to four annas over the commercial type 8-A. Under *barani* conditions where soil is poor, 9-D still holds the fields. Another wheat C-518, which can withstand lodging, has become very popular in the irrigated areas on heavy soils. Both C-591 and C-518 do not tiller as much as 8-A and their grains are heavy, therefore, a higher seed rate is needed The possibility of growing wheat at Lahaul (Kulu) in summer has made it possible to grow two crops in a year and this fact is of utmost importance for research in wheat breeding.

Rice.

Out of a total area of 80 million acres under rice in British India the Punjab has less than a million acres. Nevertheless it is an important crop in certain hilly tracts and in the submontane area with high rainfall and in the low lying reverian localities. High class rice can be grown in the Punjab The Department of Agriculture has introduced some foreign varieties and evolved some high yielding strains. Of the coarser varieties *jhona* 349 and *sathra* 278 are high yielding. 370 *basmati,* 41 *mushkan,* and 7 *mushkan* are of very superior quality and fetch a high price in the market.

Gram.

Total area under gram in British India is about 16 5 million acres and of these the Punjab contributes 3·5 million acres. This crop flourishes in all kinds of soils but does best in well-drained sandy-loam. It is sown from the end of September to the middle of October and is harvested during March-April. During certain years the prices of gram have been higher than the prices of wheat, evidently because the total quantity produced has not been much. The Department of Agriculture has produced some high yielding varieties. One of the problems which the gram growers have to fight against is the gram-blight. Researches of the Mycological section have determined that the disease is carried from season to season by the spores in the soil and in the remnants of the crops which are left about carelessly. Certain varieties are more resistant to this disease.

Barley.

The malting and brewing qualities of several types of barley have been investigated and two strains Nos. 4 and 5 have been given to the growers. The Imperial Council of Agricultural Research financed a scheme to study this crop.

Sugarcane.

On an average for 5 years, ending 1936-37, the area under sugarcane represents 13 per cent. of the total area under this crop in British India (⅓ million acres out of a total of 4 million acres).

The climatic conditions of the Punjab are not very favourable for sugarcane and not infrequently frosts destroy the crops over an extensive area. Average yield is also low as compared with other sugarcane zones, such as U. P. and Behar.

The Department of Agriculture imports improved varieties from Coimbatore Sugarcane Breeding Station. These varieties are tested at various local Sugarcane Breeding Stations. After these trials they are given out to the farmers. Co.-285 was given out in 1931. It is very hard variety and grows well in all soil conditions and has given good results even in *barani* area. It is the standard variety of sugarcane. Co.-312 is a very heavy yeilding variety, giving as much as 160 maunds per acre on very heavy soil. Co.-313, a very early ripening variety, is also a very heavy yielder. Another variety, Co 396, is very early ripening.

Through improved methods of cultivation and by introducing high yielding varieties, the Department of Agriculture has encouraged sugarcane growing. A great deal of work has been done in improving cane-crushing mills and in inventing improved furnaces.

Some sugarcane factories have been started in the Punjab and in the neighbourhood of these sugarcane growing has concentrated. Ratooning has become an important practice and has unfortunately led to increase in pests. Sugarcane borer and Pyrilla are the most serious pests of this crop.

Sugarcane surveys have been carried out and results obtained will be of advantage to the growers and sugarcane factories.

Cotton.

Cotton is one of the most important crops for the Punjab farmer as it is his chief money crop. The area under cotton in the Punjab is 3 million acres, *i.e.*, slightly more than 1/10th of the total area under cotton in British India. Of this area a little more than half is under *Desi* cotton and the rest under American varieties. Most of the cotton is grown under irrigation, only a small part is *barani*, The average yield is about 6½ maunds of cotton (both *desi* and American) in canal colonies. For the Province as a whole it is 4½ maunds for *desi* and about 5 maunds for American cotton.

To evolve suitable varieties work was started about 1905 and 4-F cotton (American variety) was given out to the farmers in 1913. This is a general purpose variety and now occupies over 10 lakhs of acres It sells at about Re. 1/- per maund above the *desi* cotton varieties. L. S. S.- a selection from 4-F cotton has the character of the latter but gives higher yields in the Lower Chenab and Lower Jhelum Canal Colonies. It occupies an area of about 1.5 lakhs acres. 43-F—another selection of the American cottons is an early ripener and has a long staple. It is also very popular in the northern part of the Lower Bari Doab Colony and on inundation canals. It is believed that it occupies about one lakh acres. 289-F is a variety of American cotton suitable for the Lower Bari Doab Canal Colony and Multan tract.

Of the *desi* varieties Mollisoni 39 is the best under Lyallpur conditions and Sanguineum for the Multan tract and Rosea-10 for the Hansi tract. Recently a long staple cotton —a cross between the Mollisoni and the Chinese Million Dollar has been produced. It contains the features of its Indian parent as a heavy yielder and the staple length of its Chinese parent. If it justifies the expectation of Mr.

Mohd. Afzal, its producer, it will be the future cotton of the Punjab.

The Indian Central Cotton Committee have contributed liberally towards research on cotton in the Punjab. Every few years the American Cotton fails more or less completely over large areas. The causes of the failures are not clear. Milne believed that excessive heat and lack of moisture injured the protoplasm. Another view is that some soil factors are responsible for this. The Indian Central Cotton Committee are financing a scheme of research to discover the causes of the failures.

Oil Seeds.

India, perhaps, produces in commercial quantities a greater variety of oil seeds than any other country. Recently oilseeds have come into greater prominence because of the demand for vegetable oils and solid fats. Oils are also used in the manufacture of lubricants, varnishes, paints, etc. Oil cakes are an important cattle food and an important source of manure.

Of the oil seeds the most important are *sarson* and *toria*. The Oil Seed Botanist has produced many high-yielding varieties of these. Recently the Department of Agriculture introduced ground-nut and this is extending very rapidly in certain tracts, particularly in the Ludhiana district. Ground-nut is a *kharif* crop and does best on light sandy-loam.

Fodders.

No improvement in the livestock of a country is possible without adequate provision for sufficient and suitable fodders. Under Punjab conditions where the holdings are small, the cultivator produces what is required for himself and his family and to pay his revenue. The fodder takes a very secondary place in farm economy and, therefore, the cattle are not properly fed.

Until recently *chari*, *guara*, *bajra*, *moth* and maize were the only *kharif* fodders and *sainji*, *sarson*, *maitha* were the *rabi* fodders. During April and May, and October and November no green fodder was available. Berseem, Sudan grass and Teosinte have been introduced to cover this gap. Berseem is one of the best fodders and is gaining popularity. Various types of *jowars* have been evolved, particularly *jowar* No. 21 is very sweet and high-yielding. Elephant grass which provides fodder throughout the year has been introduced.

~~Green~~ Miscellaneous Crops.

Millets, tobacco, patatoes, medicinal plants and plants of insecticidal and industrial value are being studied at the Agricultural Research Institute and its sub-stations, and many valuable strains placed at the disposal of the cultivator.

Horticulture.

In the Kulu valley and the Simla hills, the Punjab grows the finest qualities of apples, pears, cherries, walnut, etc. In the lower hills can be grown peaches, plums, apricots, almonds, loquats and olives. In the plains citrus and mangoes flourish, and guavas can be grown everywhere. In certain areas excellent pomegranates can be raised and grapes grown. In the south-west Dera Ghazi Khan, Multan, Muzaffargarh and even at Lyallpur excellent dates are produced. Persimmons flourish in the hills and in certain localities in the plain. Bananas are grown but they are not high class. Litchies and papayas have been tried with success.

In fruit growing and fruit preservation Punjab is well advanced. Inspite of the fact that the Fruit Section of the Department of Agriculture, Punjab, was started as late as 1926 very rapid progress has been made. As a result of the advice that is now available a marked improvement has been effected in the existing orchards. Between 1928—33, an increase of over 25 per cent. in the area under fruit was effected and since then the progress has been rapid. The new orchards are laid in a proper manner. Trials of numerous foreign and indigenous varieties have been made and nurseries of suitable varieties organised. From Government nurseries plants are supplied at moderate rates.

There is a large experimental garden at Lyallpur where researches on the problems of horticulture are carried cut. Varietal trials are made, prunning, spacing, manuring, etc., etc., are studied under local conditions. There are demonstration orchards attached to Agricultural Farms in many places.

Fruit preservation has received great attention With the assistance of the Imperial Council of Agricultural Research an up-to-date section for producing fruit products on semi-commercial scale has been established. Advanced courses in fruit and vegetable preservation and manufacture of fruit products are given.

Fruit growing and preservation forms an integral part of the training of a student of Agriculture, proposals are in hand to give further importance to horticulture in the courses of studies.

Agricultural Implements.

The indigenous bullock-drawn implements used by the Punjab farmers are two : A simple wooden plough with an iron point serves both as a plough and a cultivator. It is also a seed-drill and an inter-culture implement In different parts of the Province the shape and size is modified to suit local conditions. The second implement is a wooden beam which is a combined roller clod-crusher and a soil compactor. In light loamy soils, these two implements perform all the multifarious functions on the farm. However, to plough up stubble fields, to sow crops in lines and to harrow and inter-culture crops thus sown, other implements are needed. The Department of Agriculture has introduced some soil-inverting iron ploughs, such as the Maston plough for very light soils, and the Hindustan plough for heavier soils. There are several thousands of these ploughs in use in the Punjab. In addition to this some seed-drills have been evolved and some simple harrows designed. Some of these have been taken up by the farmers.

Another labour-saving implement which has taken on in the Punjab is the chaff-cutter and several hundreds of thousands of these chaff-cutters are in use and are manufactured locally in various parts of the Punjab. The three roller iron cane-mill is another implement which has gained popularity and is manufactured in the Punjab.

Among the water-lifts the iron Persian wheel has come to stay and those of the roller bearing type are a great improvement. The sweet music of the wooden Persian wheel has given place to the mechanical metallic sound of the iron structure.

A cheap winnower has been designed.

Of the hand implements there is a variety which has not altered much during recent times.

Manures and Manuring.

Most of the Punjab soils are deficient in organic matter and nitrogen, but contain a fair amount of potash and are not lacking in phosphates. They respond to organic manures much better than to inorganic fertilizers. Moreover, the present fall in the prices of agricultural produce makes the use of inorganic fertilizers impossible in ordinary farming. This shows that every ounce of organic manure must be preserved. Every effort is being made to persuade the farmer to husband his manural resources. Pitting of farmyard manure is being encouraged and its use as fuel discouraged. Further to encourage green manuring special facilities are being provided. The Irrigation Department foregoes water rates and revenue for the crop which is ploughed under as a green manure. The availability of irrigation water for growing a crop of *guara* or sannemp is the limiting factor in the use of green manuring. In the rain fed areas green manured fields cannot grow wheat or any other crop in the following season. This is a great drawback. Efforts are being made to encourage compost making, but this useful measure of increasing the manural resources on a farm is still in its infacy The problem before the Punjab is how to increase the fertility of her soil. Till this problem has been solved the high-yielding strains that have been evolved will not yield the best results.

The problem of nitrification have been studied. In the Punjab soil bacterial activity is the main source.

Disease and Pest Control.

The Department of Agriculture maintains a very large staff for research on insect pests and for their control. The research staff is mainly stationed at Lyallpur, but there are sub-stations at Kulu and Jullundur for specific problems. Arrangements are made to study local pests and diseases on the spot whenever necessary. A number of simple, inexpensive and effective control measures have been evolved. The more important of the problems which are receiving attention at present are the Borers of sugarcane, maize and rice, the sugarcane leaf hopper and other pests of this crop, the Bollworms of cotton, the Cotton White-fly. Against San Jose Scale and Woolly Aphis and Citrus Psylla large scale control measures have been undertaken, and the pests brought under control.

Similarly large scale spraying has been undertaken to control withertip and canker of citrus.

The Indian Central Cotton Committee has been financing schemes of research on pests of cottons. The Desert Locust Research Scheme of the Imperial Council of Agriculture Research was initiated at Lyallpur, and continued till 1933 and still continues on a small scale.

A regular study of the feeding habits of the birds of agricultural importance is made.

The Entomological Section of the Punjab Agricultural College is perhaps the biggest entomological organization in India. Recently a very wise step has been taken by appointing a special plant protection service for field control measures against pests and diseases. This will enable the research workers to carry on their investigations unhampered.

In case of fungal diseases much advance has been made. The loose smut of wheat is controlled by the solar energy method. The problem of gram blight has been solved. Many fungal diseases are being studied. The Indian Central Cotton Committee are financing a scheme of Cotton Root Rot.

Animal Husbandry.

There are about 16 million heads of cattle in the Punjab. Of these about four million are bullocks, 2·7 million cows and 3·1 million she-buffaloes. There are about 14 bullocks and male buffaloes per 100 acres.

The important breeds of cows are :—

Hissar ;
Montgomery ;
Dhanni ;
Dajal ;
and of buffalows ;
Murra ;
Nili.

The Hariana or Hissar breed of cows is mainly bred in the south-eastern districts of the Punjab. The cattle of this breed are active and tall with white or grey colour, tight skin, wide chest, long legs, small feet and short tail. The bullocks are very good for ploughing and rapid road transport, but the cows are not good milkers. There is a large cattle farm at Hissar for breeding bulls of this herd. As milch cows, the Montgomery (Sahiwal) breed is the best. The cows are small in size with thin and soft coat, large udder, long tails and long, massive and deep frames. They are usually red or red and white mixed. Bullocks of this breed are rather sluggish. The Dhanni breed and Dajal breeds are also prized for draft purposes. The former is bred in Jhelum, Attock and Rawalpindi districts and the latter in the Muzaffargarh and Dera Ghazi Khan districts.

The Punjab Agricultural College Dairy was started in 1913, with a herd of 20 cows and a bull of the Montgomery breed. The progress made is evident from the table below. The yield of milk has gone up more than three times.

Year.	Average over-all daily milk yield per cow in lbs.
1914-15 ...	5·6
1919-20	8·60
1924-25	9·03
1929-30 ...	11·40
1934-35	16·54
1935-36 ...	17·14
1936-37	18·95

The buffaloes are noted for their capacity of producing large quantities of milk rich in butter fat. The only two important breeds being Murra and Nili. The Punjab buffaloes are exported to Bombay, Calcutta and other big cities in India and also exported to Burma and Malaya States.

So far no efforts have been made to improve the breed of the buffaloes but the Agricultural College has taken up the problem on a small scale. A small herd of buffaloes was started in 1936. If it is possible to bring about the same improvement in case of the buffaloes as has been possible in the case of the cows we may revolutionise the Dairy industry.

Dairying industry is still in its infancy in the Punjab, except that near large towns dairies are springing up. Training in dairying is an important part of the training of an Agricultural graduate, in addition a course of six months' duration in dairying is given at the Punjab Agricultural College. An excellent dairy well-equipped with modern appliances is available for instruction.

Animal Nutrition.

Systematic work on the determination of the feeding values of the Indian cattle food has been in progress in the Chemical Laboratories of the Punjab Agricultural College for the last 15 years or so. Feeding values and actual digestibility of the various natural and cultivated fodders, green silage and hay, different concentrates and roughages, have been carefully worked out.

Apiculture.

The Department of Agriculture, Punjab, took up the question of bee-keeping a few years ago. At present two bee farms are run. One of these is situated at Raison (Kulu) and is in charge of Mr. Sardara Singh, a Graduate in Agriculture, who had been sent to America for training in Apiculture. The other farm is at Nagrota (some 50 miles from Pathankot). These farms are run under most modern conditions. Two courses in bee-keeping are given, one at Nagrota during February to April ,and the other at Raison during August to October. The bee-keepers are being helped with advice and supply of appliances.

Poultry Farming.

The Department of Agriculture has a large, well equipped poultry farm at Gurdaspur. Important foreign breeds are maintained and eggs supplied to public. The most important part of the work is the evolution of indigenous strains of high quality for egg laying and for table purpose. Good progress has been made in both directions. A special staff has been appointed to study poultry diseases.

Fisheries.

Attempts are being made to improve the fisheries of the Punjab. In the hill streams of Kulu trout was introduced a few years ago and is to-day the chief attraction of the valley. Unfortunately, lately some deterioration has been noticed. Investigations are in progress to study scientifically the food of this fish and to take steps to improve the quality and increase the number of trout.

Investigations have been started to determine the possibilities of fish culture in the tanks and ponds of which the Punjab has a large number. Experiments are to be started in the near future in a tank 18 acres in area. This experiment will be watched with great interest by all those who are anxious to increase and improve the food supply of the country. If the experiment is successful a way will be opened for increase in fish and addition of valuable protein food.

Trade.

The Punjab is a Province of peasant proprietors whose pre-eminent basic activity is the raising of crops. Till recently its agriculture was of the self-sufficing type. The rapid extension of the canal system removed the disability of shortage of water from which large areas suffered, and made it possible to open up a vast fields for the exploitation of soil. The opening up of Suez Canal in the seventies of the last century brought the Punjab fields within thirty days of the consuming markets in Europe. Extensive use of iron steamships from the eighties onwards and the development of internal rail and road communications, and easier modes of transport paved the way for an increased production. The Punjab became a surplus-producing Province for certain agricultural commodities.

Per head of population the Punjab grows at present about 0·4 acres of wheat, 0·2 acres of gram, 0·13 acres of cotton, 0·12 acres of *bajra*, 0·04 acres each of rice, maize, rapeseed and *jowar*, 0·03 acres of barley and 0·02 acres of sugarcane. As regards the trade in these commodities cotton and wheat are of importance. Much of the wheat exported from India goes from the Punjab. The foreign wheat trade, like that of cotton, however, has been adversely hit by overproduction and unsettled economic conditions in the world. In internal trade, large quantities of wheat and wheat flour are exported to

Rajputana, U.P., Delhi and N.W.F.P. while Behar and Orissa have come in as new markets. Gram is largely consigned to Madras, barley to U. P. and rapeseed to Karachi and foreign countries. Trade in *bajra*, *jowar* and maize is small, while in the matter of rice Punjab is self-sufficing as it imports practically as much coarse rice as it exports fine rice (mostly *basmati*) which is prized in big cities of India.

Punjab imports appreciable quantities of *gur* and sugar, mostly from the United Provinces, oil-cakes, steel and iron in manufactured forms, cotton piecegoods and some other manufactured products. Thus Punjab mainly exports raw materials and imports manufactured products. This indicates the need for development of industries if the Punjab is to be self-supporting. Some awakening has already taken place and the establishment of textile mills at Okara and Lyallpur, paint and varnish works at Lahore, and manufacture of silk and rayon products at Amritsar may be cited as examples.

The data regarding the export and import trade of the Punjab are entirely lacking from 1922 to 1933 as the publication of statistics regarding the rail and river-borne trade was abandoned during this period for reasons of economy. The figures that are now available in a published form give incomplete information as they relate only to rail and river-borne movements of commodities and do not take into account the road-borne traffic, which of late has assumed great importance. It has been estimated that of the total exchanges of commodities between the Punjab and the Indian States and other Provinces, 30 per cent. takes place by road.

Much attention has been devoted to the increase of production by the introduction of improved varieties of crops, better methods of cultivation and by devising measures for control of insect pests and fungal diseases. The business side of farming, in other words marketing, has come in for serious consideration only lately. A marketing section was started recently. The work carried out by this section shows that there is a great waste in marketing methods and has brought to light several malpractices. To mention only a few of the findings there is a confusing multiplicity of market charges and practices, the weights and measures in use are faulty, the methods of storage are primitive and defective, adulteration is rampant in some commodities, there are no arrangements for arbitration of disputes and the cultivator is usually at a disadvantage. Regulation of markets is long overdue and the Marketing Bill which provides for the licensing of marketing functionaries and setting up of market committees on which both growers and traders would be represented will be a useful measure.

Agricultural Education.

In Agricultural Education the Punjab has made much progress and agriculture receives attention at every stage.

(a) *Middle School Farms and Garden Plots.*

The scheme of agricultural education in middle schools came into force in 1919 and was introduced in schools with 3 to 5 acres farms or 4 *kanals* plots attached to them. In order to bring the school courses nearer the daily life of boys in rural areas, so that they maintain interest in agriculture, a scheme of rural science was introduced in 1934. The school farms and garden plots are educational institutions and the work done there is mainly designs to render the teaching of agriculture and rural science effective. Many of the farms and plots are managed so successfully that they incidently exercise very healthy influence in improving the agricultural methods in the neighbourhood. The teachers incharge of these farms and garden-plots help in securing improved implements or seeds of better varieties of crops for the village zamindars.

Garden plots as educational institutions are very popular because they are least expensive and most paying to the local bodies which finance them. They provide practically all the facilities for practical work in rural science for school children though on a somewhat smaller scale, than fully-equipped farms do. Farms and garden plots are divided among individual students and groups of students who are held responsible for all agricultural operations there.

The scheme of rural science has established a sympathetic contact between the school and its surroundings. Its practical character involving hard work has brought home to the boys the dignity of manual labour.

All these farms and garden plots are managed by Senior vernacular trained teachers who have undergone a year's course of training in agriculture and rural science at the Punjab Agricultural College, Lyallpur.

(*b*) *Agriculture in High Schools.*

Agriculture in high schools is taught in two distinct types of institutions :—

(*i*) There are high school centres of agriculture in few cities where students of different high schools participate in agricultural work on a common farm.

(*ii*) There are also high schools situated in purely rural areas, with very high percenatge of sons of zamindars, where agriculture is taught. The success achieved in such schools has exceeded all expectations. A large number of students have come forward to take up agriculture as a hobby and they take a very keen interest in the practical work on the farm. There are at present 10 Government, five district board and seven schools under private management, which are recognised for the teaching of agriculture in the high department. The total number of students studying agriculture in the year 1937-38 was 4,092 out of which 2,428 had taken it up as a regular subject of study and 1,664 as a hobby. All the 10 high school farms in Government Schools are running at a profit which amounted to Rs. 1,079-5-3 during the year 1937-38. The net profit from 5 district board high school farms during the same year was Rs. 259-11-9. Most of these school-farms are managed by graduates of the Punjab Agricultural College, Lyallpur.

It is expected that agriculture in high schools will receive a further impetus as revised syllabus combining science and agriculture has been framed.

(*c*) *University Agricultural Education.*

There are two colleges affiliated to the University of the Panjab in the Faculty of Agriculture : the Khalsa College, Amritsar, and the Punjab Agricultural College, Lyallpur.

While the Khalsa College, Amritsar, has the Faculty of Agriculture in addition to other Faculties, the Punjab Agricultural College, Lyallpur, is a purely Agricultural Institution. Besides providing instructions for B. Sc. and M. Sc. Degrees in the Faculty of Agriculture, various courses are given, some in vernaculars and some in English, the more important of which are : a course in Agriculture in vernacular of a year's duration : a course in vernacular in Dairying of 6 months' duration : a course for training *Malies* of a year's duration ; a seven months' advanced course in Fruit and Vegetable Preservation ; a course in Bee-keeping. There is a course for training village *lohars* for repairing implements, as also a year's course for trained teachers in Agriculture for rural schools.

Attached to the College is a big Agricultural Research Institute—one of the biggest in India. The area of the College estate is 761 acres.

Grant of Land to Educated People.

Some years ago the Government of the Province initiated a scheme of making grants of approximately 50 acres of land to each graduate. The grantees were to live on the spot and cultivate the land directly. The experiment has been very successful and most of these youngmen have shown initiative and enterprise. A further extension of the scheme is under consideration. The number of graduates in agriculture who have been so far selected for such grants is 88—these educated and trained farmers are sure to exert great influence on the standard of farming.

CHAPTER X

RURAL RECONSTRUCTION IN THE PUNJAB

BY

F. L. BRAYNE, C.I.E., M. C., I.C.S.

Rural Reconstruction is the regeneration and revivifying of the countryside by the people themselves working in co-operation with each other and with Government. The objective is better villages and healthier, happier homes. The movement embraces every activity of village life and every villager from the cradle to the grave.

Rural Reconstruction is thus a many sided subject and it will be best in this brief review to start by taking it item by item.

Economic.

The necessity for economic improvement is to many the whole of Rural Reconstruction. It certainly looms large Government plans include both increased production and the reduction of waste. There is much poverty but until the avoidable poverty is eliminated, it is impossible to attack the hard core of unavoidable poverty. There is much waste and inadequate use of land, labour, water, time and capital : topsoil is being eroded, estates, industries, opportunities of improvements are being neglected, and people who should be setting an example of how to live in the villages are living in the towns, thereby reducing rural employment and adding to the urban problems.

1. *Better production includes*—

   (*i*) Better Farming.
   (*ii*) Better Animal Husbandry
   (*iii*) Soil Conservation.
   (*iv*) Consolidation of Agricultural Holdings.
   (*v*) Better Industries.
   (*vi*) Better distribution, *i. e.*, better transport, marketing and finance.

(*i*) *Better Farming.*—Research and experiment have enabled Government to show the cultivator how to make the land far more productive by—

- (*a*) Better seeds.
- (*b*) New and better crops, *i. e.*, more marketable, more nutritious or more productive.
- (*c*) Better implements.
- (*d*) Better methods of cultivation.
- (*e*) Collection of, and new kinds of manure.
- (*f*) Eradication of crop pests and diseases.

(*ii*) *Animal Husbandry includes* —

- (*a*) pedigree breeding,
- (*b*) control of disease.
- (*c*) better feeding, and
- (*d*) better keeping of cattle.

(*iii*) The conservation of soil and water includes counter-erosion work in the forests and grazing areas which are the catchment areas of our great canals, and levelling, terracing and embanking in the cultivated areas below. The erosion of the canal catchment area is perhaps the greatest economic menace at present overhanging the Province The loss of the vegetation in the hills, besides ruining the poor hill folk, reduces the cold weather supply of the canals and fills them with silt ; it reduces the level of the water in the wells in the plains below, raises the levels of the river-beds, causes disastrous flooding in the monsoon, spreads infertile sand over the fields, damages bridges and canal works, washes away villages and cuts away arable land.

There is special forest staff already dealing with this subject, plans are being made for more staff and for fuller co-ordination of the work, and the attention of the revenue authorities is being rivetted on the conservation of the arable lands.

(*iv*) The consolidation of fragmented agricultural holdings has long been a co-operative enterprise. This work is being rapidly expanded and the Revenue Department has also started doing it.

(*v*) ***Industries include***—

- (*a*) Better methods.
- (*b*) Better and more marketable designs.
- (*c*) New Industries.

A few of the industries subsidiary to arable farming, such as bee-keeping and poultry are dealt with by the Agricultural Department, dairying and sheep-breeding are dealt with by the Animal Husbandry Department. But in general the Industries Department deals with the whole of this vast subject and like agriculture, has discovered enough to make a fair livelihood for those who will work hard and follow good advice.

(*vi*) *Distribution.*—It is no good growing good crops or making good articles, if they cannot be marketed, and at prices which will give both grower and middleman a reasonable return for their labour and capital. This means

(*i*) better roads. Government is attending to both village and metalled roads :

(*ii*) co-operative enterprise, by which the producer may buy raw material and equipment, sell the finished article, secure easy credit and obtain information of the best methods and designs.

Mass production is killing village industries but for those who do make full use of co-operation, it is believed that there is still a living to be obtained in many industries, particularly those with the advantage of local raw products or local markets. Laws have been and are being made to assist the villager in marketing and in his financial dealings.

A few instances of the economic prospects now made available by Government must suffice.

Cotton sown in lines and properly cultivated will produce not less than two maunds more cotton per acre than present methods. There are about 3 million acres of cotton harvested annually. At only Rs. 5 per maund, the extra produce is worth three crores of rupees or more than the whole land revenue of the Province.

If animals are flayed according to the improved methods now taught by the Department of Industries, the hide is worth about double what it is, if flayed by present methods.

Milk kept hot in a haybox instead of simmering over a cow-dung fire, gives about ten per cent. more *ghi* and will save millions of tons of cow-dung every year for use as manure.

The average milk outturn per cow is extremely low. By the use of pedigree bulls and careful attention to feeding, this could soon be doubled.

The topsoil of an agricultural country is its biggest national asset. In the eroding areas, it has been found that levelling, terracing and embanking of the fields increase the crops outturn up to double.

II. *Reduction of waste.*—Waste is a great feature of rural life, such as the (*a*) waste of manure by the burning of cow-dung and the absence of proper arrangements to collect refuse, etc., (*b*) waste of health by all manner of unhygienic customs and practices, (*c*) waste of time and labour by the use of inferior implements and methods, cattle and seed, (*d*) waste of credit by the habit of borrowing for unproductive as freely as, and even more freely, than for productive purposes.

The positive waste of money on litigation, social ceremonies and other extravagances is being discouraged by co-operative organizations, and the habit of saving is being encouraged, without which no permanent rise in the standard of living is possible.

Health.

Wealth is of little use without health and there is much unnecessary ill-health and suffering in our villages. The following are a few of the measures being taken to improve health :—

(*i*) *Vaccination and revaccination*—Primary vaccination has now reached practically one hundred per cent. and revaccination at intervals of six or seven years is spreading rapidly.

(*ii*) *Ventilation*—Few new houses are now built without standard ventilators and hundreds of thousands of old houses are being fitted with them or with some other means of letting in light and air.

(*iii*) Well tops are being improved to ensure pure drinking water.

(*iv*) *Cleanliness of all kinds: Personal, Domestic, Communal*--Villages are being cleaned and often kept clean. Pits are being dug and drains are being built and streets paved. Latrines are still unpopular.

(*v*) Waste water is being used for growing trees, vegetables and flowers, depressions are being filled, cheap mosquito nets are being made and marketed by the Co-operative Department and a scheme for quinine distribution is being drawn up.

(*vi*) A net work of village dispensaries has been spread over the Province, the doctors in charge are beginning to tour the villages and to do what they can for the preventive as well as for the curative side of health.

(*vii*) A beginning has been made with rural health centres in charge of Lady Health Visitors, and village midwives are being trained. There are as yet, however, very few lady doctors and practically none in the villages.

(*viii*) Many schools have Junior Red Cross Branches and first-aid posts. The medical examination of school children has been started.

(*ix*) Nutrition surveys are being made. There is much mal-nutrition but, until the avoidable mal-nutrition—caused by ignorance, carelessness, or social prejudices against the growing of vegetables and fruit—has been eliminated, it is difficult to tackle the mal-nutrition due to poverty or inability to grow the right foods.

Education.

The school is being developed as the cultural centre of the village and the curriculum is being increasingly adapted to rural needs. The school boys are doing more and more to help all sides of the programme of village improvement. Scouting is a common activity, organized school games and village games are increasing in popularity. Girls' education is receiving increasing attention, but it still attracts less than 5 per cent of the money spent by District Boards on Education. Government desires that the Village Primary School should enlist both girls as well as boys and opposition to this, especially where female teachers are employed as well as male, is decreasing.

General.

Rural Reconstruction means culture and civilization and is, therefore, interested in recreation of body and of mind, in flowers, in pictures, in needle-work and in the teaching of the women to make nice things for themselves, their children and their homes, in touring cinemas, in radios, in songs and dramas, in books and newspapers and in the spread of the habit of reading and in all else that makes life happier and sweeter and village life less dull and monotonous.

Crime and the drift to the town are both in part the result of boredom, so village life must be made full and interesting, as well as healthy and economically sound.

Leisure time must be made for the overburdened housewife and her load of drudgery lightened. The bullock-driven flour mill must replace the handmill, and the wheel-barrow must replace the rubbish basket carried on the head. Labour saving contrivances for the home must be devised, such as better cooking grates and kitchens, chimneys to get rid of the smoke, street paving, washing places for women on the wells and better latrine arrangements. Mud walls must be weather-proofed to save both labour and the eternal digging that in time makes the surroundings of every village a swamp.

A saving system must be developed that will help the village family to level out the irregularities caused by capricious nature and still more capricious prices, and to tide over the hard times which must otherwise destroy the new standard of living so carefully built up.

The ever rising tide of population is perhaps the most difficult problem of all but in all countries and civilizations, the rising of the standard of living has materially helped to solve it—in some countries has over solved it!

A scheme has been launched by Government this year whereby each tehsil in turn is to be intensively attacked for three years. Each year a new tehsil in each district is taken up. Special money has been allotted, five lacs the first year, ten the second and fifteen the succeeding years until tehsils have all been taken up, when the annual allotment will progressively decrease.

No special department has been created for this work. It is in charge of the district and the departmental staff with what reinforcements can be afforded. An informal board of departmental officers, presided over by the Deputy

Commissioner, organizes and co-ordinates the work in each district. A Commissioner on special duty with a small staff advises and co-ordinates, and organizes what propaganda there is money for.

The All-India Radio Programme includes a Villagers' Hour but the price of radio sets and the difficulties of servicing them and of recharging batteries have prevented the spread of the listening-in habit to the villages. Some money has been provided for cinema films but here too, there are many difficulties in the way. There are village newspapers in some districts but they are run with difficulty and their circulation is inadequate.

Many gramophone records have been made and coloured pictures for village walls are under preparation. The Co-operative Department runs a very successful company of village players. Models are exhibited and posters, handbills and pamphlets are distributed. Shows competitions, demonstration meetings, conferences, refresher courses, and other forms of mass instruction are organized as far as exiguous funds permit.

The principles and as far as possible the practice of Rural Reconstruction are taught to the serving Indian soldiers in cantonments.

The above is a very brief and incomplete outline of Government's Rural Reconstruction activities. For further information, enquiries are referred to "BETTER VILLAGES"—(Brayne) Oxford University Press, Bombay.

It is one thing, however, to plan better farming, better health and better business, it is quite another to secure its universal acceptance and adoption. The horse has been taken to the water. How will he be persuaded to drink!

By dint of many years of effort, the use of improved wheat seed has spread to perhaps half the area sown to wheat in the Punjab. Several years of effort have not spread the sowing of cotton in lines to more than 4% of the area under cotton. The use of ventilators and the digging of pits and all other improvements require steady and continuing pressure. And so with everything. The difficulty is not so much to find ways of increasing production and improving health as to get people to adopt them. The lag between laboratory and field is disappointingly great. It would hardly be an exaggeration to say that enough has been discovered to enable the villagers to double their resources and to halve their diseases. Every year more is being discovered, but the people are far from keeping pace. Research and discovery are getting further and further ahead. This does not mean that nothing is happening in the villages Since the war and particularly in the last ten or twelve years, a vast change has come over the village and over the mind of the villager. His tempo of change and improvement is rapidly quickening. But even so the main problem of Rural Reconstruction is still to make the villager want better things. He has to be fired with ambition for a higher standard of living. He must be convinced that there is a manner of life which is better than the life he now leads and that this new manner is both possible and desirable – infinitely more desirable than his present condition.

Rural Reconstruction is an uphill struggle for the villager. It means hard work and demands sacrifices and the laying aside of favourite extravagances and besetting sins. It means sinking differences and working together. It means breaking with old customs and habits. It means saving and scraping. Why should the villager undertake all this unless by doing so he will gain something which he is genuinely convinced is worth while?

How is this conviction and this ambition for better things to be implanted in the heart of the villager?

There are several ways:—

(*i*) Education and well-organised publicity and propaganda, to put before him and before his wife and children the picture of better things;

(*ii*) far more important, the personal example of all those, official and non-official, to whom by reason of education, wealth, religious, social or official position, the people look up. Every villager must have living active samples of the better life;

(*iii*) the organization of the village by means of *panchayats* and co-operative societies, so that leadership may be effective and there may be agencies to put into practice better things as people learn to want them, and to provide the necessities, amenities and recreations of civilised village life ;

(*iv*) female education, women's welfare work, women's institutes and organizations of all kinds. The home is the centre of the nation. Better homes are our objective. The guardian angel of the home is the housewife or *gharwali*. It is she who is responsible for the feeding, the clothing, the health and happiness of the home. She sets the pace and fashion of home life. She it is who brings up the young. Without her help therefore there can be no rise in the standard of living and no 'better homes' movement. But how can she help till she is taught how to ?

Many customs must be changed in this 'better homes' movement. Women are the guardians of custom and tradition.

Violent crime is on the increase ; there is far too much litigation, bribery and false evidence. The old sanctions are going, the new sanctions of moral training and discipline are not yet fully operative. We have already noted that Rural Reconstruction means working early and late, saving and scraping and much self-denial and self-sacrifice. But it is the mother who forms the character of the child, starting from infancy with regular feeding, and going on to clean and regular habits and truth speaking. Who but the mother can instil the old virtues of self-respect, self-control, truthfulness, thrift, self-denial, hard work and pride in craftsmanship and in good work well done, without which no 'better homes' movement can prosper.

But how can the housewife take her proper place and do her full work in the home till she is trained ? Female education and women's welfare and training work of all kinds, doctors, midwives, women's organizations and institutes are, therefore, the most important of all work for the achievement of Government's purpose of raising the standard of living in the Punjab villages and of making this movement spontaneous and continuous.

This unfortunately is the most backward part of the Punjab rural movement. But its importance is now beginning to be recognised. Increasing attention is being paid to the needs of the women in education, hygiene, co-operation and general welfare. A whole time welfare worker has recently been appointed, a domestic training school has been started and advisory committees of ladies are being formed in the districts.

Rural Reconstruction thus embraces the whole of village life, economic, hygienic, domestic, social and spiritual. But inasmuch as man has a soul and his actions are prompted and governed by his spirit and his character, any neglect of this side of the work must bring failure to the whole movement.

If I were asked what were the foundations upon which could be built this great structure of rural civilization which the Punjab Government has planned for its Province, I should say they were—

(*i*) for the land, the consolidation of holdings and the conservation of top-soil;

(*ii*) for the village, personal example and organization in the shape of *panchayats* and co-operative societies:

(*iii*) for the home, the building up of a savings system and the education, training and organization of the women.

With these foundations, all the rest will follow, without them, each new thing will require special and continuing efforts and nothing will be permanent.

Note.—For those who are interested tours can be arranged to see the work actually going on in the village themselves. For this purpose Lyallpur and Montgomery districts are recommended, to see canal colony villages. For other villages within reach of Lahore, Hoshiarpur, Jullundur, Gurdaspur, Shahpur, Ferozepore, districts, and Kasur sub-division are specially recommended but in nearly all districts good examples of the better village movement can now be found

CHAPTER XI

UHL RIVER HYDRO-ELECTRIC SCHEME

OPERATED BY

THE PUNJAB PUBLIC WORKS DEPARTMENT, ELECTRICITY BRANCH.

CONTRIBUTED BY

THE CHIEF ENGINEER, P. W. D., ELECTRICITY BRANCH.

The generating plant belonging to the Punjab Government and operated by the Electricity Branch of the Public Works Department is situated at Jogindernagar in Mandi State, a distance by road of 200 miles from Lahore. Jogindernagar can be reached by train from Lahore by broad gauge to Pathankote and changing there to a narrow gauge line which traverses the Kulu valley passing through Kangra and Palampur and terminating at Jogindernagar. If the trip is by road, it should be realized that one way traffic only is permitted from the Ghatta Toll to Jogindernagar, a distance of 10 miles from Jogindernagar, and it is advisable to arrive at the Toll Bar in time for the up traffic so as to avoid a tedious wait. The timings which are different for the summer and winter season may be obtained from the Office of the Automobile Association of Northern India on request.

The generating station at Jogindernagar at present comprises four 12,000 kw. units driven by 17,000 B.H.P. impulse type turbines and this installation may be considered as the first stage only of this scheme, which can be extended by two more stages to an ultimate capacity of 119,000 kws.

The Uhl River Hydro-Electric Development broadly speaking consists of taking the waters of the Uhl River flowing at an elevation of 6,000 feet above sea-level through a tunnel 3 miles long, into the valley of the Neri Khad, so that the tail water from the impulse type turbines, is delivered into this Khad, at an elevation of 4,000 feet. The scheme is divided into three parts.

The first one consists of a Headworks to collect the waters of the Uhl and Lamba Dag Rivers, a decantation chamber to free the waters from matter in suspension. The necessary flumes and ducts to carry this water to the tunnel, a diurnal reservoir to be used during the low water period when the water is clear and a three mile tunnel through a ridge of the Dhauladhar range, a Surge Shaft and the necessary Penstock Pipes to carry the water to the impulse type turbines in the Power House. The two rivers mentioned above are typical mountain streams which obtain their supply from the melting of the snows on the surrounding ranges as well as rainfall. As no snow melts on the high ranges during the winter months, naturally the winter months are a period of low flow for both these rivers and during this period the water is clear, carrying no sediment and can therefore, be utilized in conjunction with the diurnal reservoir without danger of silting to the reservoir. When the combined flow of the two rivers approaches 600 cusecs there is a tendency for the water to become charged with a fine silt and during the monsoon period of maximum flood, when the flow has been known to rise to over 4,000 cusecs, the water is very heavily charged not only with silt, but fine sand and the rivers bring down shingle and boulders. These characteristics necessitated a design which would enable the silt laden water to be passed direct to the tunnel without giving it an opportunity of depositing the silt in the bottom of the diurnal reservior and also the building of some form of sluice which would allow the shingle and boulders to pass the decantation chamber and on down the river bed without blocking the intake. Normally in rivers of this type, the erection of an obstruction such as a weir across the bed has the effect of raising the whole bed to the level of the top of the weir, since the shingle and boulders pile up on the upstream side of the weir : thus building up the bed and making the impounding of the water above the weir impossible. To prevent the possibility of this occurring, the weir has not been made continuous across the Uhl River but is broken by two gates; one an ordinary counter-balanced lifting gate and the other a falling gate 26 feet in width which can be lowered into a recess leaving its surface level with the bed of the river and of sufficiently robust construction to allow of its supporting 15 ton boulders rolling down with the flood water. Both upstream and downstream of these two gates, the river-bed has been floored with massive stone sets, set in cement mortar with the narrowest possible joints. When the gates are raised or lowered as the case may be during flood, the shingle and boulders are allowed to pass straight through down the river and thus prevented from building upon the upstream side of the weir. As soon as these shingle and boulder-carrying floods are over, these two openings are closed by their respective gates and the normal impounding action of the weir is obtained. The difficulty regarding the introduction of silt laden water into the diurnal reservoir was overcome by building a forebay at the upstream end of the diurnal reservoir connected to the tunnel by an 8 feet duct passing below the bed of the reservoir. At the downstream or near the downstream end of the reservoir a Y piece was built into this duct, controlled by valves and with one end connected to an intake equipped with trash racks in the bottom of the reservoir. The forebay was also equipped with a spill which passed surplus water back to the river and an intake gate and duct, allowing water to flow into the reservoir. The operation then became quite simple, since with the flow of 600 cusecs there is no necessity for a diurnal reservoir, this flow being sufficient for the full ultimate capacity of No. 1 plant, having an output of 72,000 kws. During the low water periods when it is necessary to utilise the diurnal reservoir to carry the peak load, the clean water is run into the reservoir and the tunnel is fed through the reservoir intake. As soon as the water becomes silt bearing, the gate into the reservoir from the forebay is closed and the water enters the tunnel direct through the duct under the bed of the reservoir.

The tunnel is a pressure tunnel which in the present stage is subjected to a head of approximately 35 feet at the Brot end and 110 feet at the foot of the Surge Shaft in the Jogindernagar valley. The lowest point of the tunnel is at Adit Junction where it is subjected to a head of 130 feet and where sand and gravel scour valves have been installed enabling any sediment which may have been deposited in the tunnel, to be scoured out through the Adit. The surge shaft is of the diaphragm type with a central chimney. The diaphragm round this chimney is equipped with ports through which the water rises or falls with the increase or decrease of pressure in the tunnel, caused by the change in velocity of the water in the Penstock Pipes. The central chimney which has an internal diameter of 5 feet naturally makes the quickest response to the change of pressure but the flow of water through the ports filling the anulous of the surge shaft around the central chimney, has a stabilising effect, and reduces the surge to approximately 50% of what it would have been had the surge shaft been built without this central chimney and the diaphragm. The water leaves the bottom of surge shaft by means of the two pipe tunnels 6 feet in diameter, which bifurcate at the Tunnel Exit into 4-5 feet diameter pipes which are equipped with Butterfly valves above the automatic stream-line valves. The original design called for a further bifurcation of these 5 feet pipes, where the static pressure became too great for a normal pipe of this size but this second bifurcation was made unnecessary by the adaptation by banded steel pipes, so that the lower half of the Penstock Pipe Line consists of banded steel pipes which bifurcate again just outside the Power House where each pipe is controlled by a Bell rotary valve before being connected to the inlet bend of the needle controlling the jet of the impulse turbine.

The switchgear is of the totally enclosed type, metal clad and is located in the switch house which is part of the main generating station building. From the basement of the switch house the cables run in a square concrete slab duct, to the step-up station above the Power House. The cables are carried through this duct on side racks and are connected through delta houses on to the low tension side of the 11,000 to 132,000 volt transformers. These transformers are connected through a substation mesh system on the 132,000 volt side by means of oil immersed circuit breakers on to the main transmission line.

Transmission.

The transmission lines from the generating station both trunk and branch have been erected under the Telegraph Act, the powers for which were conferred upon the

Chief Engineer by Government. Before reaching a decision as to the method to be employed, very careful consideration was given to the problem. It was found that three other systems had been tried in India, *e.g.*, the erection of lines as by a licensee under the Indian Electricity Act, the purchase of a strip of land the length of the transmission line and sufficiently wide to prevent encroachment on the distance from the centre line necessary for the conductors to swing out under a gale at right angles to the direction of the transmission lines at a period of maximum sag. Then the resale of this strip of land back to the original owners for agricultural purposes with a " way leave " incorporated in the Deed of Sale to permit the transmission lines being constructed. Third, the purchase of rights to build and maintain transmission lines through private property by the payment of annual fees, such fees varying in amount according to the crop planted in the vicinity of the towers and under the conductors. An examination of the operation of these systems showed that each had its defects.

It was found that to attempt to erect lines as a licensee under the Electricity Act, where the permission of the owners had first to be obtained involved such a lengthy process in the hills where holdings are in many cases so small that the 24 feet square base of a tower would sometimes require negotiations with four land owners, admittedly of the same family but not always amicably inclined towards one another that at the lowest estimate three years would have to be allowed for the legal procedure before commencing erection of the line.

In the case of the purchase of a strip of land and then its resale to its original owners it was found that the original owner would only repurchase if the land was rich and valuable for the production of crops and that where the land was poor while the purchase price might have been originally raised, the resale price was nil.

In the case of the annual payments, it was found that the staff required to maintain the registers and periodically visit the fields and record the type of crop which was being grown in each small holding was such that it added a considerable burden to the annual charges and if this was not done, every land holder throughout the length of the line would claim that he had been growing or was about to grow the most expensive crop from the point of view of annual fees whether or not the land was suitable for such a crop. A further consideration was the fact that the purchase of so much land meant an additional heavy capital expenditure which would in all probability mean a piling up of unpaid interest during the early stages of the scheme before it came into full operation. It was felt further that erecting the lines under the provisions of the Indian Telegraph Act did not really work a hardship on the land owner since it did not preclude him from obtaining compensation where compensation was really due.

The trunk transmission line consists of two 3-phase circuits, carried on galvanized steel double circuit towers, except for a mile on each side of the substation where each circuit is carried separately on single circuit towers with a horizontal spacing. This trunk line runs to Kangra, Pathankote, Dhariwal, Verka (Amritsar), Shalamar (Lahore). At each of these substations are sectionalising switches so that in the event of trouble on one of the circuits, the faulty section may be cut out of service, while supply is maintained by the other circuit between the two substations affected and both circuits elsewhere.

The 66,000 volt branch lines are single circuit lines, carried on galvanized steel towers, the conductors being carried in the same horizontal plane throughout.

There are two of these lines radiating from the Shalamar Station, one approximately 100 miles long, terminating at Lyallpur, and passing through Sheikhupura, Chuharkana, Mohlan, Jaranwala, and the other 50 miles long terminating at Ferozepore and passing through Kasur.

From Amritsar a Branch 132,000 volt line has been built to Jullundur, a distance of 48 miles, where a transformer station is installed for local supply and also for supplying a branch line at 33 kw. to the town of Ludhiana passing through Phagwara, Goraya, and Phillaur. In addition to these extra high tension lines, there are 11,000 volt branch lines between Dhariwal, Gurdaspur and Dinanagar, Dhariwal and Batala, Verka and

Tarn Taran, Mohlan and Nankana Sahib Thus a length of over 400 miles of Extra High Tension transmission lines cover the area served by the Project. In addition there are local distribution systems in the following towns:—

Pathankot, Dinanagar, Gurdaspur, Batala, Amritsar Suburban, Ludhiana, Tarn Taran, Kasur, Ferozepore, Baghbanpura, Sheikhupura, Chuharkana, Nankana Sahib, Jaranwala, Lyallpur, Lahore Suburban, Kartarpur, Dhariwal, Kangra, Goraya-Phillaur, Tankanwali Basti, Qadian, Lower Dharamsala, Jullundur Suburban.

These local distribution net works consist of 11,000 volt primaries and 400-230 volt secondary systems with their own substations, the supply to which is controlled by 11,000 volt switchgear in the main trunk or branch Extra High Tension substation.

At the date of commencing commercial supply (March 31st, 1933), 4 generators had all been installed and operated, although their final tests for efficiency and full load capacity had not been completed. The main transmission line had been completed except for a few details which had come to light in the final inspection, such as insulators being mounted with the wrong type of bolt, or the absence of split pins. The main substations had been energized as far as Lahore but had not been finally tested and inspected. The telephone line had been installed and was operating between Lahore and Jogindernagar, but not on the branch lines, the local distribution systems had not been completed in any of the 16 towns provided for in the project estimate for local distribution, although work was well advanced in 4 or 5 of them, but the applications for supply had been pouring in at a satisfactory rate so that it seemed probable that the growth of load would be fairly rapid. Prior to the commencement of operation of the Uhl River Scheme, this Branch had been supplying the Amritsar Municipal Committee with power purchased from the Lahore Electric Supply Company and transmitted from Lahore to Amritsar over one of the circuits of the Main Transmission Line between those two towns. In order, therefore, to commence supply from the Hydro-Electric plant at Jogindernagar, it was necessary to make changes in connections at the Verka Substation and at the same time, since the load at Amritsar was only in the neighbourhood of 1,200 kws, to connect in a 10,000 kw. synchronous condenser at Lahore in order to hold down the voltage of supply. The whole of this work was successfully carried out with only a stoppage of supply of 12 hours to the Municipal Committee, Amritsar.

While various attempts have been made in the past to forecast the rate at which load will be attracted to and connected up in this scheme, at the commencement of the commercial operation there was without doubt, a definite attitude on the part of the public to wait and see. The result was that although the mills and industrial consumers were available in the district, it was impossible to get them to sign a contract until the power had definitely arrived at the village and was shown to be satisfactory by ocular demonstration. This meant that there was a definite time lag between the arrival of the electrical energy on a local distribution net work and the connecting up of the load, since many of the inhabitants had refused to have their premises even wired until they were assured by the appearance of the light in the Branch substations, that they really would get satisfactory service and similarly the Mills and factories had definitely postponed either signing agreements or ordering the necessary electrical equipment for their Mills, so that a definite lapse of time will take place before the anticipated load can be connected

Nevertheless it is of interest to note that at the present time five years after the commencement of public supply by this undertaking the load connected on to the distributing mains of the Branch exceeds 36,000 kws., although it has not been possible to make arrangements for the sale of power in the City of Lahore itself, through the private Company which at present holds a license for this area. The operation of this undertaking has been carried out in a most economic manner and during 1936-1937 the total maintenance charges amounted to only Rs. 2,90,790 giving a rate of 48% on capital works including Establishment and Tools and Plant charges. The total establishment charges during the same year amounted to Rs. 8,71,678 and this sum includes the cost of the local offices in the distribution centres numbering 24 as well as the generating, transmission and distribution staffs. The total revenue was Rs 23,18,374, being an increase of approximately 18 lakhs over the revenue of the first year of operation.

For visitors who propose visiting the works, it may be mentioned that to facilitate construction of the Headworks, Tunnel and generating station, it was necessary to build haulageways for the transport of the heavy machinery, cement, aggregate for concrete and food supplies and these haulageways are still maintained and on special occasions passes are issued to visitors for the transport of themselves and their equipment from Jogindernagar to Winch Campt an elevation of 8,000 feet upon the signing by the visitor of a document freeing Government from all responsibility and from all liability to pay compensation in the event of any untoward happening.

The 132,000 volt lines which carry the power away from the generating station traverse the Kangra valley for a distance of 100 miles before debouching on the plains at Pathankot and on their way down they have to span great chasms over 3.000 feet in width. The normal tower which carries the two circuits one on each side is 86 feet above ground. The towers are made of galvanized steel with their footings resting on concrete pads 9 feet below the surface of the ground, but where these big chasm have to be crossed, it proved impossible to use this type of tower and other types had to be designed to stand the additional strain caused by the weight of the conductors in these long spans To prevent disturbances on the telegraph and telephone lines which traverse the same valley, the relative positions of the six wires comprising the two circuits are changed so that any induction introduced by one conductor into a communication circuit due to its paralleling the main transmission line will be neutralized by the opposite induction effect introduced by another conductor in the same length of parallel. These same precautions of course were carried out in building the Branch s own telephone system, which has to parallel the 132 and 66 kw. lines all over the area reticulated in order to enable the staff to control the operation of the system and restore service as quickly as possible after any interruption. This departmental telephone system has several unusual features, one being that all local calls are automatically closed down when the control circuit is brought into use by the Power Controller or other authorized person whose messages thus have right of priority over all messages on the system and no intermediate or local station can cut in or interrupt the control circuit when this is in use. The necessity for this requirement is of course obvious for should any serious mishap occur it is of the utmost importance that instructions should be conveyed without interruption to the seat of the trouble so that service may be restored at the earliest possible moment. The main transmission voltages utilized are 132,000 and 66,000 and of course these voltages are very much too high to be of any use to consumers either retail or bulk, without transformation. Also the cost of transforming these voltages to pressures suitable for the suppiy of consumers is too costly to allow of its being done except for large amounts of power at convenient centres, but the voltage must be of the high order chosen to prevent excessive loss in transmitting the energy over the 400 miles of High Tension Transmission Lines. To overcome this difficulty, step-down stations are located at convenient centres along the lengths of these transmission lines and here the voltage is reduced from 132,000 or 66,000 to 11,000 volts for distribution in bulk or retail to the consumers of the Branch and in 24 towns the Branch also reduces this 11,000 volts to 230-440 volts for distribution in retail to house-holders and small power consumers.

The foregoing paragraphs give a brief idea of the present position of this Electric Undertaking, but it must not be considered for a moment that this is static.

New Projects for the extension of the existing ditsribution systems and the design and building of new ones are constantly being examined and at the present time Projects for the extension of the distribution mains towards Multan, Sargodha, Sialkot, Gujranwala, Wazirabad, Chak Jhumra are either in process of investigation or have been submitted to Government for their consideration and for the last year a Division has been employed in making an exhaustive examination of the possibilities of securing load throughout the

Punjab and as a result of their load survey, it has been found that a market for 119,000 kws. is available in portions of the Punjab not yet touched by the distribution lines, while within the area already reticulated there exists a load of not less than 50,000 kws., so that it is confidently expected that the Electricity Branch will be called upon to extend not only the transmission and distribution lines far beyond their present limits, but in the very near future will also have to undertake the building of additional generating stations to supply power to the market which exists.

The phenomenal growth of load revenue in this Branch of the Public Works Department is due not only to the low rates at which electrical energy is supplied but also to the absence of several restrictive conditions common to other Supply Authorities. Although the rates were set as low as possible (for light and fans varying from 4½ annas to 2½ annas depending on the size of the installation) it was felt that other inducements should be held out to prospective consumers to encourage the rapid building of the load so it was decided that instead of demanding that a new consumer should pay in cash the cost of the service line to his premises beyond 100 feet this extra length and the necessary equipment on the consumer's premises would be supplied on the basis of a small monthly rental. Another concession which has been greatly appreciated by the public is the omission of a stated term of years in the contract between the Branch and its consumers. Few of the prospective consumers felt they wished to bind themselves to use electric energy for a lengthy period till they had a chance to try how it worked, but the Branch feeling confident that the service given would be so satisfactory that once the many advantages of using electricity had been experienced, no one would wish to do without it, advocated the exclusion of a fixed period from the agreement and time has shown the confidence to have been justified.

Industrial consumers with prime movers of their own were offered a special discount of 12½% for 5 years from their power bills if they closed down their own plants and converted to electric drive within a year of Electric Supply becoming available in their vicinity and every endeavour was made to assist them to calculate the cost of electrical operation of their plants. Every employee of the Branch is encouraged to become a Salesman and courtesy to the public is a *sine qua non* with the entire staff. The growth of load and revenue up to the present and the frequency with which requests for the extension of the existing lines come from the public presage a bright future for the Electrical Development of the Punjab, the expansion of its industries and the prosperity of its people.

CHAPTER XII

THE HISTORY AND PRESENT POSITION OF MEDICINE IN THE PUNJAB

BY

VISHWA NATH, M.A., M.D., F.R.C.P.I., D.P.H., D.T.M. & H.

History of Medicine in the Punjab up to 1860

In the history of medicine of ancient India the Punjab occupied an important position. Parts of this Province adjoining Sind were the home of the Indus valley civilization of 3000 to 2500 B. C. Archæologists have discovered substances like *Silajit* and cuttle bones used in the indigenous systems of medicine, stored in the pottery of that period. The Vedic age concerns itself chiefly with the Punjab and it must have been here that the hymns of the *Atharva Veda* on Osteology, Parasitology and clinical description of certain diseases were composed. The expanded .versions of the same found in the Brahamanas must also have had their origin here. It was, in all probability, in the Punjab that Bharadwaj taught Atreya who according to Hindu tradition was the founder of the Ayurvedic system of medicine. Atreya's disciples wrote six compendia or *Samhitas* on medicine, of which only those of Agnivesh and Bhed are known at present. Charaka's reduction of the former is still the best known work on Ayurvedic medicine. Buddhist Jatakas describe Taxila as one of the two outstanding Universities in India, the other being Kashi or Benares. This tradition cites Atreya as the leading Professor of Medicine at Taxila at or shortly before the time of Buddha. The same tradition describes Charaka as the celebrated physician to King Kanishka who ruled over Northern India and surrounding territories about the beginning of the Christian era. Charaka must have been in his time a teacher in the Atreya line. His writings were subsequently added to by Dridhabala who is said to have been a resident of Panchnad, interpreted by some scholars as the Punjab and by others as a particular town in the Kashmir valley. The Buddhist period is also regarded as the most fruitful from the point of view of exchange of medical knowledge with Greece and other countries. Between the 4th and 7th century A. D. accounts given by foreign travellers, particularly of the time of Chandara Gupta and Harsha, show the existence of numerous charitable hospitals maintained by the State. From the 7th and 8th century A. D. there was also evidence of intercourse with Arabia in the field of medicine. Very little is known about the development of medicine in the post Buddhist period in the Punjab. From the time of the Ghaznavide occupation down to the Moghul period conditions in the Punjab were too chaotic for science and learning to flourish. But there were writers on Ayurvedic medicine at this period and judging from their names, some at least, must have been inhabitants of Kashmir. There is evidence that in the Moghal period physicians were employed to render medical aid free of charge to the people, but it cannot be claimed that any place in the Punjab during this period gained reputation as a seat of learning comparable to that of Taxila. Of medical aid in the time of Maharaja Ranjit Singh a fairly detailed view can be obtained from the account written by Dr. Honigberger—a Transylvanian, who was a physician to the Court at Lahore at that time. There was a Dar-ul-Shifa (Hospital) in the city which was under the direction of the two famous fakir brothers, Aziz-ud-Din and Nur-ud-Din. This hospital had also a surgical section under experienced *jarrahs*. The jail also had a hospital attached to it. Dr. Honigberger in addition to being a physician to the Court was also incharge of the gunpowder mill and gun manufactory. He did a considerable amount of operative work in addition. There were also English doctors attached to the Residency who practised medicine.

The Medical College at Lahore.

The real beginnings of scientific medicine in the Punjab, however, date from the year 1860 when the British Government opened a Medical School in Lahore. The project was conceived by Sir John Lawrence in 1857, but was actually carried out in 1860 when Sir Robert Montgomery was the Lieutenant-Governor of the Punjab. That the first college to be opened by the British Government in the Punjab was a Medical College, shows the high value attached by early administrators of the Province to the cause of medical education. The College was opened in the old artillery hospital in Anarkali, which was situated on the site where the Government College now stands. The hospital attached to the College was on the site occupied by the Police Thana in the Tibbi Bazar of Lahore. It had only 2 Professors and a Sub-Assistant Surgeon. The College changed its premises in 1864 and again in 1883. The Mayo Hospital which is attached to the College and accommodates 475 in-patients for teaching purposes, was erected in 1870. Substantial additions were also made to the College buildings in 1893. In 1915 it came to be designated the King Edward Medical College. Its premises and that of the attached hospital were re-modelled and extended on a huge scale involving an expenditure of Rs. 41 lakhs. The Government Hospital for Women and Children, now designated the Lady Willingdon Hospital, was opened on the 1st March, 1930. It is one of the most up-to-date Maternity Hospitals in India. It has, however, at present accommodation for 75 in-patients only—a number which does not prove adequate for the training of medical students of the King Edward Medical College. The King Edward Medical College is an older institution than the Panjab University which came into existence in 1872. From 1860 to 1869 the College gave its own license to practise medicine and surgery. From 1869 to 1881 the Panjab University granted the College Graduates the diploma of L.M.S. or M.B., according to the basic qualifications with which the candidates joined the institution. Since 1912 the Panjab University have been granting the degree of M.B., B.S. to graduates of the College Different departments of the College are open to post-graduate workers as well and this facility is availed of both by Government through periodic refresher courses given to its Provincial Service Officers and by other medical graduates desirous of specialising in laboratory technique or obtaining post-graduate qualifications. The degree of M. D. (Punjab) has been obtained by 12 Graduates of the College and M. S. (Punjab) by 4. The College admits 90 students every year including 10 women students. It has 545 students on its rolls at present. Government spends nearly 5 lakhs of rupees on the institution every year. If expenditure on the hospitals attached to the College for clinical teaching is included it comes to Rs. 9,82,777. At its inception the College had 2 Professors, 1 Apothecary and a Sub-Assistant Surgeon as its staff and but 5 students. It has now a staff of 9 whole time I.M.S. Professors, 2 part-time I.M.S. Professors and one whole time and one part-time non I.M.S. Professors. Nine Clinical Assistants, 4 Assistants to Professors, 11 Demonstrators and 9 Assistant Demonstrators. The expenditure to-day is over twenty times of what it was at the beginning. The College also trains students for Membership Examination of the Punjab State Medical Faculty.

The de Montmorency College of Dentistry.

The Punjab is the first Province in India to have opened a College of Dentistry. The Punjab Dental Hospital was erected at a cost of nearly Rs. 3 lakhs in 1929. The de Montmorency College of Dentistry was opened in 1934 and was affiliated to the Panjab University a year later. The course for the B. D. S. extends over a period of 4 years but medical graduates can obtain this degree after a training of 2 years and licentiates of the Punjab State Medical Faculty can obtain the diploma of L. D. S. after a similar period of instruction. There is a great demand for the admission to this College The initial qualification required for admission is the same as in the Medical College, *viz.*, F. Sc. medical group. Basic sciences and elementary general medicine and surgery are taught to the students of this College in the King Edward Medical College and the rest of the course is pursued in the Dental College itself.

The Medical School at Amritsar.

The training of medical licentiates for the Sub-Assistant Surgeon cadre was also carried on in Lahore between the year 1860 and 1920. In 1920 the Medical School was separated from the College and transferred to Amritsar. It is one of the best institutions of its class in India. 100 students are admitted to this school every year of whom 25 are women students. It carries an I. M. S. Officer as its Principal, has 8 whole time lecturers, 6 part-time lecturers and 12 demonstrators. For clinical teaching a hospital of 310 beds is attached to the school. A class is also conducted under the auspices of this school for Dressers and Dispensers to which 30 students are admitted every year. The course extends for 18 months and is followed by an examination conducted by the Punjab State Medical Faculty. The Ophthalmic Department of the Hospital attached to this school has in-door accommodation for 150 patients and has been an important centre for the treatment of eye diseases in the Punjab for several years. The institution of a Diploma in Ophthalmology at this centre is expected to materialise shortly.

Medical Education for Women.

The Medical College in Lahore has been a co-educational institution since many decades Before the institution of the M B, B. S degree in 1912, it admitted Lady students for training with the regular University classes. These students were, however, examined not by the University but by the College itself. At the end of a 5 years' course certificate to practise medicine was granted to these students This class was subsequently abolished and now about 10 women students are admitted every year to the regular course of training for the M. B., B. S. degree. The Medical School at Amritsar is also admitting a growing number of lady students every year. The Province also pays a subsidy of Rs. 10,500 to the Lady Hardinge Medical College, New Delhi, for the training of 7 women students from the Punjab

The Christian Women Medical College at Ludhiana.

The oldest and best known institution for training lady doctors in the Punjab is the Christian Women's Medical School at Ludhiana run by Dame Edith Brown. This school is very widely known since it admits students from all over India. The institution came into existence in 1894, as the result of a unanimous decision arrived at a year earlier by a conference of medical missionaries working in the Punjab and N.W.F.P. and was recognised in 1897 as an institution for training lady sub-assistant surgeons. The Memorial Hospital attached to it has done remarkably good work for the relief of suffering amongst women in the Punjab. This School receives a grant of

Rs. 94,500 per annum from Government in addition to substantial lump sum grants given from time to time for its hospital which has in-door accommodation for 264 patients. The Silver Jubilee Fund placed a sum of Rs. 50,000 at the disposal of this institution for radium in 1936. In addition to training lady doctors this institution also trains sick nurses, midwives, and lady health visitors. The Panjab University has recently given permission for training M.B.,B S. students in Anatomy and Physiology.

The Medical School for Men at Ludhiana

Ludhiana also claims the distinction of having a private Medical School for Men which has been in existence for the last 4 years and the students of which have been admitted so far to the examinations of the State Medical Faculty of the Punjab—up to the 3rd Professional Examination. This institution is purely a private venture and is the outcome of the initiative of a certain number of local medical practitioners. The institution is administered by a Trust presided over by an Ex-Judge of the Punjab High Court. In the event of this institution fully satisfying the requirements of the Punjab Medical Council and receiving recognition, the cause of voluntary effort in the field of medical relief and medical education will receive good impetus.

Medical Relief in the Punjab.

The Punjab spends more per head of population on medical relief than any other major Province in India. Available statistics also show that a relatively larger number of patients attend centres of medical relief than is the case with other Provinces. This does not imply a higher rate of sickness or mortality, for the Province records a lower death-rate, a lower infant mortality and fewer cases with incurable infirmities than most Provinces in India. Since the inaguration of the Montford Reforms in 1921 medical relief, particularly in rural areas, has expanded more rapidly in the Punjab than in other parts of India. The credit for initiating this policy of expansion rests mainly with the late Sir Fazal-i-Hussain who set before himself a programme of providing a dispensary for every 100 square miles of area and every 30,000 of the population. The programme also included a transfer of hospitals at district and tehsil headquarters from the control of local bodies to that of the Provincial Government and providing lady doctors in all such hospitals to afford medical relief to women. This involved adding to the hospitals and dispensaries existing at that time, 375 more dispensaries. The building and equipment of each dispensary was to cost a sum of Rs. 7,000 and its maintenance a sum of Rs. 2,500 per year. This programme stands realised to the extent of 364 dispensaries of the above-mentioned type being in existence in the Province to-day. There is also a scheme aiming at creating subsidized dispensaries. The maintenance cost of each is to be Rs. 1,200 per annum: Rs. 600 as an allowance for the doctor and the rest for medicines. Nine units of this type have already been established and the success achieved with these may lead to further extension of medical relief in rural areas. Although the Punjab stands foremost amongst the Provinces in India both in its plans and achievements in the field of rural medical aid and preventive work the existing arrangements still fall short of the ideal aimed at by the late Sir Fazal-i-Hussain, *viz.*, the provision of a dispensary for every 30,000 inhabitants and for each area of 100 square miles. An improvement of existing medical aid and public health propaganda is sought by requiring doctors incharge of rural dispensaries not to confine their work to the dispensary premises alone but to move about in the surrounding villages after dispensary hours and carry medical aid to the homes of the sick. This experiment is being tried over several districts of the Punjab and may become a special feature of rural medical relief in the Province. The problem of creating a shift of medical talent to the country side is of great importance to a Province like the Punjab, but it does not admit of an easy solution. The Punjab is not behind any other Province in India in her efforts to solve it successfully and without delay.

The Punjab Mental Hospital, Lahore.

The hospital provides accommodation for 1,008 patients (598 in cells, taking one patient each, and 410 in barracks, calculated on the basis of 70 superficial feet per patient). There is considerable overcrowding in the hospital in that the number of patients under treatment in the hospital at the end of the year 1928, 1935, 1936 and 1937 was 1107, 1008, 991 and 981 respectively. Admission is restricted to curable cases only and for want of accommodation a number of criminal and non-criminal patients could not be admitted. The additional accommodation for 300 male patients has been completed and will be brought into use shortly. The proposal of providing additional accommodation for 100 female patients has been sanctioned and funds provided for the purpose. The staff consists of one I. M. S. Officer as Medical Superintendent, 3 P. C. M. S. Officers —one as Deputy Medical Superintendent, another as Assistant Deputy Medical Superintendent and one Lady Assistant Surgoen who is in charge of the Female Section. In addition to this staff 2 Sub-Assistant Surgeons are employed on the male side and 5 nurses who are designated as Matron and Assistant Matrons on the Female side. The total number of attendants employed is 123. The cost of maintenance of a mental patient in the hospital has been fixed at Rs. 20 per mensem. The Local Bodies pay the cost of maintenance of their patients at flat rates on a population basis, District Boards at annas eight per 1000 patients and Municipal Committees, Small Town, Notified Areas and Cantonment Authorities at Re. 1 per 100 patients.

The total expenditure incurred on the maintenance of the hospital during the year 1937 was Rs. 3,20,647 as compared with Rs. 2,99,945 in 1936 and Rs. 3,03,556 in 1935. The recoveries were as follows :—

1935 ...	. Rs. 1,66,536
1936 .	... Rs. 2,49,461
1937 .	. Rs. 2,92,191

Organisation of Medical Department.

The following statement will give an idea of the total strength of the Medical Department in the Punjab :—

I. M. S. Officers .	36
I. M. D. ,,	9
P C. M S. Officers in superior service as Civil Surgeons; ...	9
as Clinical Assistants in the King Edward Medical College	8
P. C. M. S. Officers as Assistant Surgeons ..	155

Sub-Assistant Surgeons	...	564
Medical Officers incharge of Rural Dispensaries	...	360
Dental Medical Officers	...	4
Female Civil Assistant Surgeons	...	3
Female Sub-Assistant Surgeons	...	42
Total	...	1,190

This large staff of medical officers is controlled by the Inspector-General of Civil Hospitals, Punjab, and is responsible for the conduct of 913 hospitals and dispensaries spread all over the Province. These institutions represent centres of medical aid of different types as will be apparent from the following table :—

Government Institutions—		
State Public Hospitals	...	51
Police Hospitals	...	30
Canal Dispensaries	...	77
Others	...	22
Local Fund Institutions—		
District Board Dispensaries	...	590
Municipal Dispensaries	...	113
Private Institutions receiving Government Aid	...	30
Total	...	913

If other hospitals and dispensaries run by agencies other than those above-mentioned are also included the total number comes to 968.

Medical Relief by Private Agencies

There is a growing appreciation on the part of the public in the Punjab of directing private charity into the channel of medical relief. In Lahore the hospital endowed by the late Sir Ganga Ram and which commemorates his name is an outstanding example. The institution is administered by a Trust which controls an endowment, with which the hospital is maintained Part of the staff works on an honorary basis and the hospital is rendering valuable service in a very congested area in the heart of Lahore. Recently Rai Bahadur Seth Kishore Chand donated a sum of Rs. 1,00,000 for a Maternity Home at Amritsar and Seth Gujar Mal Rs. 50,000 for a Tuberculosis Sanitorium in the same town,

Diseases of Common Incidence.

Of the prevalent diseases affection of the eye account for the largest number of patients attending hospitals in the Punjab. Nearly 70 to 80 thousand attend for cataract alone every year. About thirty thousand lenses are extracted every year. Malaria, dysentery, lobar pneumonia and tuberculosis are some of the other diseases of outstanding importance. In certain districts stone of the urinary tract is relatively common and on an average over 2,000 operations are performed every year for that disease. Hook-worm infection prevails widely in the submontane districts.

Public Health Organisation, History and Personnel.

The beginning of public health activity in the Punjab can be traced to the appointment of a Superintendent General of Vaccination soon after the Annexation. In 1868, a Sanitary Commissioner was also appointed and the two departments were amalgamated in 1880. A Sanitary Board with the Sanitary Commissioner as its Secretary was created in 1890, to advise Government about the execution of sanitary works for local bodies. In 1915, 7 large towns of the Province were required to employ Municipal Health Officers ; Government guaranteeing payment of half of their salaries. 29 other Municipal Committees were required to employ at least one qualified Sanitary Inspector each. In 1920, 3 District Medical Officers of Health were appointed for working in rural areas by Government and an Education Bureau was created in connection with the Public Health Department for purposes of propaganda by preparing lantern slides. It was due to the late Sir Fazl-i-Hussain's enthusiasm for public health that the department was given an independent status and a more ample staff. In 1923, it was re-organised and 15 medical men with British qualifications in public health were added to the then existing establishment. In 1926, the establishment was still further increased so that every district in the Punjab, with the exception of Simla, came to have a District Medical Officer of Health paid from provincial revenues. The department has to-day under the Director of Public Health, 4 Assistant Directors, 34 District Medical Officers of Health, 2 Assistant Epidemiologists and a Public Health Chemist, a Nutrition Officer, a Principal of the

Punjab Health School, one Superintendent each for the Punjab Health School and the Punjab Vaccine Institute, a Medical Officer of Health, Factories and Statistical Officer and a Provincial Leprosy Officer. It has also a fair sized staff of sanitary inspectors, dispensers and Sub-Assistant Health Officers.

The Punjab Vaccine Institute.

The Punjab Vaccine Institute in addition to meeting the Provincial requirements also supplies vaccine lymph to very large areas outside the Province. Several Indian States, the N.W.F.P., Tibet, Nepal, Chinese Turkistan, Iraq, Persia and the Andaman Islands receive their supply of vaccine lymph from this institute. On an average 3½ million vaccinations have been carried out every year in the Punjab alone The year 1937-38, however, has been a record year. 5,774,130 vaccinations were carried out in this year.

The Punjab Epidemiological Bureau.

The Punjab Malaria Bureau was founded in 1910. The work done in the Bureau included malarial surveys. spleen census, the compilation of statistical data regarding epidemic diseases and the study of the habits of insect vectors of disease especially mosquitoes and their larvæ. In 1923, the Bureau was converted into the Punjab Epidemiological Bureau and its utility and sphere of action were largely increased. Its staff now consists of the Assistant Director of Public Health, Epidemiology and 2 Assistant Epidemiologists with the British Diploma of Public Health. Its researches are no longer confined to malaria, and in addition to epidemiological work proper it also carries out routine bacteriological examinations connected with diagnosis and prevention of different diseases.

Attached to the Punjab Epidemiological Bureau is a Public Health Education Bureau which the Department maintains for purposes of propaganda and publicity. Leaflets, posters, pamphlets, photographs, charts and magic lantern slides are prepared in connection with various aspects of public health and issued to the districts by the Bureau.

In addition, the Bureau undertakes the preparation and supply of photographs and magic lantern slides to the Rural Reconstruction, Co-operative and other allied Departments requiring its services.

The Public Health Department also undertakes to have radio-talks delivered from time to time by its officers on various public health subjects from the Lahore Radio Station.

Public Health Chemical Laboratory.

This Laboratory exists primarily for the examination of articles of food and drink but in particular for the operation of the Punjab Pure Food Act. Other work such as the examination of waters, building materials, chemicals used in the prevention of epidemic diseases, drugs and waste effluent from factories is also undertaken. The Public Health Chemist is also responsible for the proper working of chloronemes at a number of important water works and arranges for the chlorination of water supplies and bathing tanks at the large Provincial Fairs. In addition a course of instruction for the training of Public Analysts is held by him in the Laboratory each year.

Survey and Treatment of Hookworm Infection in the Punjab.

Hookworm infection is prevalent in the submontane districts of the Punjab. The Public Health Department has carried out an intensive survey of these and other areas in the Punjab. In affected areas 8 treatment units are functioning, each in charge of a Sub-Assistant Surgeon and supervised by a Medical Officer with British qualifications. Since 1934, under the plan for mass treatment of this disease, over 3 lakhs of people have been treated. Preventive inoculation against plague and cholera has also been greatly popularised by the Public Health Department in the Punjab.

The Punjab Health School.

For training Lady Health Visitors who could be put in charge of Maternity and Child Welfare Centres, the Public Health Department runs the Punjab Health School. With the help of ladies trained at this school 89 maternity and child welfare centres and 128 sub-centres in urban and rural areas exist in the Province. Ordinarily from 12 to 15 students are trained every year.

In 1926 the number of *dais* trained was under 50. The total number of *dais* under training at the various centres, at the end of 1937 was 1,939, while 1,609 certificated *dais* were known to be practising; 529 *dais* passed the Certificate examination during the year. During 1937 trained *dais* were instrumental in bringing 22,092 antenatal cases to the notice of Health Visitors and conducted 28,263 labour cases of which 8,461 were supervised by Health Visitors.

Health of Industrial Workers.

The department also interests itself actively in the health and welfare of industrial workers and has a Medical Officer of Health to look after factories and statistical data. He is required to inspect 862 factories in which approximately 70,000 individuals are engaged on industrial work.

Nutrition Surveys.

The department also employs a Nutrition Officer with subordinate staff for estimating the value of different articles of diet in the maintenance of health. A preliminary survey of 4 selected villages in Kangra district has been undertaken along with auxiliary surveys namely hookworms, tuberculosis, water-supply and leprosy and blood phosphorus and serum calcium estimations. It is contemplated in due course to extend the survey to other districts with a view to ascertaining the suitability and food value of different dietaries consumed in various parts of the Province.

Entomological Surveys.

A field epidemiological unit with an Entomologist and 2 Sub-Assistant Surgeons has been sanctioned shortly for surveys necessary to the control of insect borne disease like malaria.

Leprosy Survey.

There are 5 Homes for Lepers in the Punjab incharge of medical missionaries The Public Health Department has been carrying out a leprosy survey in the Province since 1931. Upril last year 6945 villages had been surveyed carrying a total population of 2½ million people. 2003 cases were discovered which were spread over 879 villages. Up to this day a survey of 18 districts has been completed. The Leprosy Officer also trains doctors incharge of hospitals and dispensaries in leprosy work, to establish leprosy clinics in connection with these institutions. 105 such clinics exist in the Province.

Medical Inspection of School Children.

The Public Health Department also helps in organising medical inspection of school children. Arrangements are in hand to secure uniformity of service in this field all over the Province.

The Sanitary Board, Punjab.

The Sanitary Board, Punjab, helped by Engineering Section of the Public Health Department have many notable achievements to their credit. The installation of water-supply and drainage in several towns and some rural areas, has been carried out by this department. The difficult problem of water-logging is being tackled seriously and a number of scientists and engineers are engaged on its solution.

Special Development Programme.

Under a special development programme a sum of Rs. 1,40,000 was sanctioned by the Government for expenditure on improvement of rural water supplies and sanitary works in villages during the year 1938-39. A further sum of Rs 1,24,000 is to be devoted to special water supply schemes in 1939-40. The active co-operation of the villages served is sought, the inhabitants contributing bricks, other material and unskilled labour free of charge for the sinking of sanitary wells and laying proper drains and pavements. It is also proposed to open health clinics in 2 districts in each revenue division at a cost of Rs. 76,000, each.

Registered Medical Practitioners in Punjab.

In addition to the medical men and women serving in the departments of medical relief and public health there is a large body of registered medical practitioners in the Punjab. There are approximately 5,000 registered medical practitioners working in the Punjab. Of these about 3,600 are settled in the British Punjab. Nearly ⅓rd of this number is employed under Government. Over ⅔rd are private practitioners. Approximately 87·6 per cent. of the population of this Province lives in villages and 12·4 per cent. in towns with a population of more than 5,000. Over ⅔rd of the total number of registered medical practitioners including both Government servants and independent medical practitioners are settled in towns, so that the number of medical men catering for the needs of the urban population is not far behind that existing in most European countries and America. The rural population, however, is inadequately served at present. The urban population has one registered medical practitioner for nearly 1,200 inhabitants. The rural population has one for approximately every 22,500 people. So far as Government arrangements for the provision of medical relief are concerned there is a hospital or dispensary for every 12,327 of the population in urban areas and 32,284 in rural areas.

The Punjab Medical Council.

The registration of medical practitioners is in the hands of the Provincial Medical Council which has a right to look after the standard of professional examinations conducted by affiliated institutions and to secure observance of rules of medical ethics. The Council has 16 members including the Inspector-General of Civil Hospitals, Punjab, as its President. 9 of its members are nominated by Government and 7 are elected by constituencies, the distinction between which is based on different types of recognised medical qualifications. The medical Council of the Punjab also serves the Provinces of Delhi and N.W.F.

The University and the State Medical Faculties.

The courses of medical studies and the conduct of medical examinations is in the hands of the Medical Faculty of the Panjab University and the Punjab State Medical Faculties. These institutions are composed of nominated members only. The Punjab is justly proud of the high standard of medical education ensured by these institutions both for the degree and licentiate classes.

The Punjab Branch of the British Medical Association.

The Punjab Branch of the British Medical Association has the distinction of being the largest branch in India and ranks fourth in the strength of its membership amongst the branches of the Association outside the British Isles. It has membership of 249 people. Although the Branch is nearly 20 years old its vigorous life date from the year 1927, when the zeal and enthusiasm of Lt.-Col. J. J. Harper Nelson revived interest in this organisation. The activities of this

Association are of great benefit to the medical profession in the Province. It provides a common meeting ground for different sections of the profession. Papers of high clinical merit are presented before its meetings and its annual gatherings are valuable both from a scientific and social points of view.

The Punjab Branch of the Indian Medical Association.

An organisation of nearly equal importance is the Punjab Branch of the Indian Medical Association which is mainly composed of the non-official section of the medical profession. It has 326 members It differs from the B. M A. in possessing 14 active branches in the moffusil. The branches hold clinical meetings and also consider from time to time problems affecting the welfare of the medical profession. Being a predominantly non-official organisation its discussion of medical politics sometimes lacked restraint. The acceptance of its membership by Government servants was therefore not approved by Government. The Punjab Government, however, has recently been pleased to remove the ban. This may lead to the development of a broader outlook on medical problems in this Association and to fruitful co-operation between different sections of the medical profession

The Indigenous System of Medicine.

Although the Punjab was the foremost centre for study and propagation of the Ayurvedic system of medicine in ancient India and subsequently Unani medicine was also introduced in to other Provinces of India through the Punjab, the indigenous systems of medicine do not occupy as high a place in popular esteem in the Punjab to-day as they do in other Provinces. The study of medicine in post-Buddhist India, divorced as it was from dissection and good surgery, became more and more theoretical and only formed a part of the general cultural education of the times. Under frequent invasions from the North and the consequent unsettled state of the Province, Medical education suffered along with general education. The result is that we hardly possess any men of outstanding fame in the Punjab as practitioners of indigenous systems of medicine. For several years after the foundation of the Lahore Medical College Government ran in connection with this institution also classes for the training of Vaids and Hakims and the Panjab University College which was the predecessor of the Panjab University granted diplomas of Hakim-i-Haziq, Umdat-ul Hukama and Zubdat-ul-Hukama to Hakims and Vaids, Bhekhak and Maha-Bhekhak to Vaidyas. The students were trained in the fundamentals of Anatomy, Physiology, Medicine, Surgery, etc., on the same lines as students qualifying as Hospital Assistants, but had in addition to appear in the Unani or Vedic systems of medicine according to the qualification desired. This class gradually disappeared with the growth of the Medical College and the Medical School. The Punjab Government now pays a subsidy of Rs. 8,000 a year to the following institutions catering for education in the indigenous systems of medicine.

1. The Dayanand Ayurvedic College, Lahore.
2. The Unani Classes in the Islamia College, Lahore.
3. The Tibbia College, Delhi.

There are in addition 3 or 4 schools of minor importance offering education in the indigenous systems of medicine in the Province. The curricula of most of these institutions provide a very elementary training in modern Anatomy, Physiology and Pathology. Registered Medical Practitioners are employed to teach these subjects. There being no registration of Vaids and Hakims in force, even the competence of men entrusted with the teaching of the theory and practice of the indigenous systems varies within wide limits. Under existing conditions, however, these systems harbour many quacks and in the words of our Premier it is difficult to separate "the grain from the chaff amongst Hakims and Vaids as elsewhere." Introduction of some system of registration for practitioners of indigenous systems of medicine is necessary in the interest of these systems, as well as for the protection of the general public. The Punjab Government has appointed a representative Committee to study this problem and recommend necessary action.

CHAPTER XIII

THE NORTH WESTERN RAILWAY

CONTRIBUTED BY

THE GENERAL MANAGER, N. W. R.

The North Western Railway serves six important Provinces of India. First comes the Punjab with its wide irrigated plains dotted with important towns and cantonments, then Sind in which is situated the Port of Karachi and where extensive irrigation projects have recently been completed. On the Frontier, the North West Frontier Province is served by a number of broad and narrow gauge lines, while Baluchistan is traversed by a strategic line through the Bolan Pass with a lengthy extension to Nok Kundi. In the Delhi Province the North-Western Railway serves the Imperial Capital, and lastly, the line traverses the western districts of the United Provinces. Junction is made with the East Indian Railway at Saharanpur, Meerut City and Ghaziabad and with the Great Indian Peninsula Railway near Delhi. The Bombay Baroda and Central India Railway metre gauge system links up with the North Western at Delhi, Hissar, Bhatinda, Fazilka and Kot Kapura, and the Bikanir and Jodhpur Railways (both metre gauge) connect at Bhatinda and Hissar, and Hyderabad (Sind), respectively. The Shahdara-Saharanpur Light Railway, a narrow gauge system, connects with the North Western at Delhi-Shahdara and Saharanpur.

Although the volume of traffic on the North Western Railway may not approach that on some of the large British and American lines, there are many remarkable features connected with this great system that may well claim the attention not only of the Railway expert but of the statesman and student of social development. In mileage it can bear comparison with the largest systems in other parts of the world. The many notable bridges such as those over the Indus at Attock, Kalabagh, Sukkar and Kotri, and over the Sutlej at Ferozepore and Adamwahan; the lines which penetrate historic mountain barriers such as those through the Khyber

Pass and over the Bolan; the uninhabited desert sections such as those in Sind and beyond Nushki, all bear witness to the successful solution of engineering problems of the first order: while the range of climatic conditions from the snow-swept Quetta hills to the scorching plains of the Indus add not a little to the complexity of traffic operation.

Historical.

Although the facilities for inter-communication in the areas now served by the North Western Railway are vastly superior to anything which has existed before, it must always be remembered that a land traversed by large and partially navigable rivers has natural lines of communication which are powerful factors in the growth of early civilization. A study of the Nile, Tigris and Euphrates might suggest that similar social conditions existed on the banks of the Indus in the dawn of history, yet till fifteen years ago no remains of early civilization had been discovered in India which could be placed anterior to the third century B. C. Recently, however, important excavations carried out under the direction of Sir John Marshall near Harappa Road Station and at Mohanjodaro near Dokri Station have, at a bound, taken us back another three thousand years, and have established the fact that in the third millennium B. C. the inhabitants of Sind and Punjab were living in well-built cities and had a high standard of art and a developed system of writing.

The mists of antiquity at present hide all historical details of that remote past, and it is not until the invasion of the Greeks in 327 B. C. that the Punjab once more comes into view. Though it is impossible to trace with accuracy Alexander's astonishing journey by land and river from the north of the Punjab to the sea, his route could never have been far removed from one or other branch of the present railway, and it is interesting to note that he took ten months to do a journey which the mail now covers in less than 24 hours. He left little or no mark, however, and it remained for the great empire builders, Chandragupta Maurya, and Asoka, who followed soon after, to make systematic efforts towards supplementing the means of communication provided by nature. Unfortunately the roads, milestones and rest-houses of these and similar enlightened administrators barely lasted beyond their life-time. Later, the Mughals set to work again to open up communications, and paved the way for the coming of the iron horse.

Early Days of the Railway.

The beginnings of the railway line date back to 1855 (two years before the Mutiny) when the Sind-Punjab and Delhi Guaranteed Railway Company was registered; the first sections of the line between Kotri and Karachi City (105 miles) being opened some six years later. In 1862 the same Company opened the section between Amritsar and Lahore and by 1870 various other sections were opened giving through connection from Ghaziabad *via* Lahore and Khanewal to Multan Cantonment.

The Punjab Northern State Railway was a State-owned line and owed its inception to the necessity of improving the communications between the Punjab and the North-West Frontier. The first section, Lahore to Jhelum, was opened in 1873 and eventually, Peshawar Cantonment was reached in January, 1883. The first section was originally metre gauge and was converted to broad gauge in 1878, prior to further extension towards Peshawar. The line between Jhelum and Rawalpindi originally contained very heavy grades and was only finally improved to its present ruling gradient of 1/100 as late as 1897.

The line between Kotri and Multan *via* Sukkur, the Nara Canal Bridge and Lodhran, was constructed as the Indus Valley State Railway and was opened in 1878. From that year until 1889 all goods and passenger traffic between the Punjab and Karachi had to be ferried across the Indus at Sukkur, the Lansdowne Bridge at that place only being completed in the latter year.

The Eastern section of the Sind-Sagar Railway originally consisted of a number of small lengths in the north of the Punjab of which the Lalamusa-Malakwal and Golra-Basal Sections were the longest. The line joining Malakwal to Shershah *via* Bhakkar was not opened until 1890 and that between Kundian and Campbellpur in 1899.

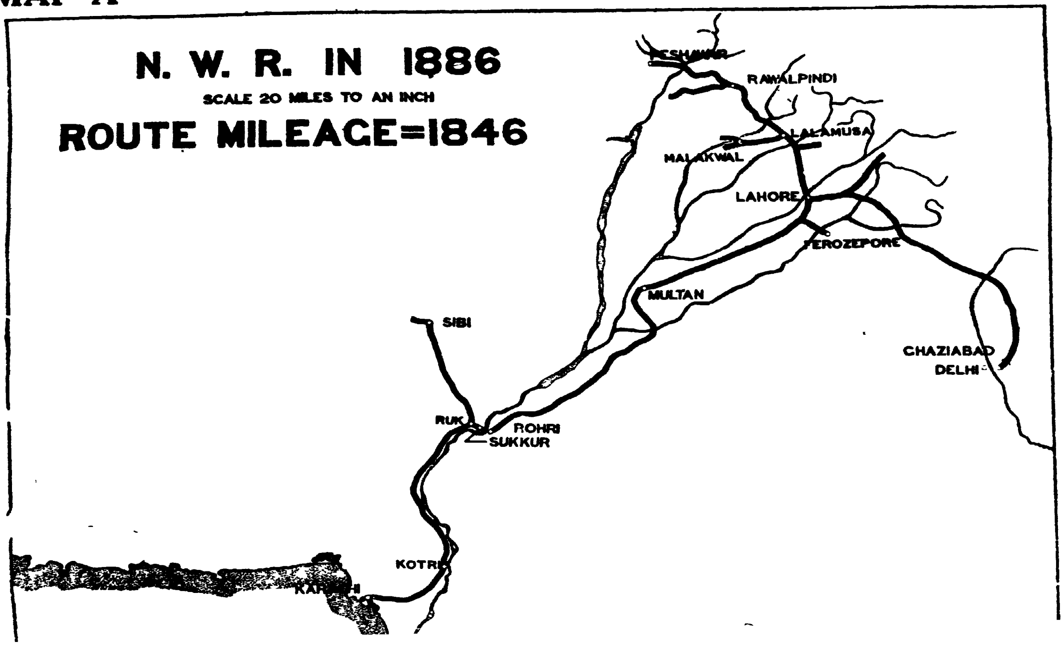
The Southern section of the Sind-Pishin Railway also owes its origin to the necessity for communications on the Frontier. After considerable wastage in life and material, it was eventually decided at the close of the second Afghan War to carry on the construction of this system as fast as possible. The line, which had reached Sibi in 1880, was extended to Quetta *via* the Bolan in 1886 with a length of metre gauge laid along the bed of the *nalla* in the most difficult section. At the same time the line *via* Harnai was being carried through to Bostan and onward to Chaman through the Khojak in 1892. The Bolan route was finally re-aligned and completed with broad gauge throughout in 1891, since which time it has been the main line to Quetta and beyond.

Reorganization in 1886.

In 1886 the five Railway Administrations which have been mentioned above were amalgamated under the name of the "North Western Railway" as a Government concern, owned and worked by the State, and the sections then under construction were rapidly completed and opened for traffic. The most important of these were the Bolan route to Quetta and the line joining Malakwal and Shershah *via* Kundian. A map showing the extent of the system at the time of this amalgamation will be found at the end of this article. (Marked 'A').

After the great famine in 1878 the Famine Commissioners urged the extension of Railways in India for the protection of the country against these disasters, and the importance of irrigation in the same connection was also pointed out. An impetus was thus given to the construction of the Lower Chenab and Lower Jhelum and the Upper Chenab and Upper Jhelum Canal systems, and with the increase in the productiveness of these areas came a corresponding demand for transport facilities. In response to this demand the Wazirabad-Sangla Hill-Shorkot Road-Khanewal line was opened in sections between 1895 and 1900, and the Malakwal-Shorkot Road and Shorkot Road-Chichoki-Mallian branches between 1903 and 1911. With the above developments taking place in the Punjab it was recognized that the single line from Sukkur to Kotri on the west bank of the Indus would be insufficient to cope with the increasing traffic, and an alternative route on the east of the river was put in hand. A second crossing over the river at Kotri was opened in 1900,

MAP A


N. W. R. IN 1886
SCALE 20 MILES TO AN INCH
ROUTE MILEAGE=1846
PESHAWAR
RAWALPINDI
LALAMUSA
MALAKWAL
LAHORE
FEROZEPORE
MULTAN
SIBI
RUK
ROHRI
SUKKUR
KOTRI
KARACHI
CHAZIABAD
DELHI

since which date the Rohri-Hyedrabad-Kotri link has been the main line to Karachi from Northern India.

Later in 1909 the Khanewal-Lodhran Chord was completed and this obviated through trains having to go round by Multan and Shershah. Various other branch lines such as the Ganda Singhwala-Bhatinda section opened in 1899 and the Jahal-Hissar and Taxila-Havelian sections completed in 1913, brought the route mileage of the State-owned portion to about 4,000 miles in the last named year.

The construction of these lines was financed by Government and they are wholly the property of the State. There are a number of lines, however, which are either the property of private companies or of Indian States. Some of these were actually constructed by the Campany or Durbar concerned while others were constructed by State Agency, the initial capital expenditure being borne in each case by the Company or Durbar. On opening to traffic, the working of each line was taken over by the North Western Railway, the whole being worked as one system. The first of these companies to come into operation was the Delhi-Ambala-Kalka Railway Company, the main line of which was opened in 1891. Then came the Southern Punjab Railway Company, whose agreement with the Government of India was signed in 1895, and whose main line Delhi-Bhatinda-Sammasatta was opened in 1897. From then onward this enterprising company made a number of extensions, the last one opened being that between Jullundur and Ferozepore. The section Bhatinda to Delhi has now become part of the main route between Lahore and Bombay. The Southern Punjab Railway was purchased by the Government of India on 1st January, 1930. The Kalka-Simla Railway, which is 2′-6″ gauge, and the importance of which lies in the fact that it serves the summer capital of India, was constructed by a private company and opened for traffic in 1903, being purchased by the State in 1906.

Besides the above, other companies, such as the Amritsar-Patti-Kasur Railway Company, the Sialkot-Narowal Railway Company, the Mandra-Bhaun Railway Company, the Sind Light Railway Company, and the Hoshiarpur-Doab Railway Company raised capital for the construction of branches, while the Patiala, Kashmir, Malerkotla, Jind and Bahawalpur Durbars also own sections of line, which are worked by the North Western Railway. All the above are of broad gauge. The Amritsar-Patti-Kasur Railway was purchased by the Government of India on 1st January, 1936.

Turning to the development of the strategic lines during the last 25 years the following sections may be mentioned. The line from Quetta to Nushki was opened in 1905 and was extended to the Persian Border, a further distance of some 300 miles during the Great War. A portion of this extension has, however, since been closed, the present railhead being at Nok Kundi. Jamrud was reached from Peshawar in 1901, and the Khyber Railway which traverses the Khyber Pass was opened in the autumn of 1925. The line between Nowshera and Durgai was originally built as narrow gauge; but was converted to broad gauge in 1921. In the same way the section Khushalgarh-Kohat-Thall was originally narrow gauge. Khushalgarh to Kohat was converted to broad gauge in 1908, the section onwards remaining 2′-6″. The line between Kalabagh on the Indus and Bannu was constructed in 1913 and extensions from Laki Marwat to Tank and Manzai were constructed in 1916 and 1921 respectively. A bridge over the Indus at Kalabagh to replace the existing steamer ferry has lately been constructed.

The Position To-day.

At the present time, therefore, the main lines of this wide-flung system extend on the one hand from Delhi, the winter capital of the Government of India to the Afghan Frontier beyond the Khyber Pass; and on the other from Simla, the summer capital through the fertile plains of the Punjab to the busy port of Karachi, the third port in importance in India. The present route mileage is about 7,000 miles while the track mileage including sidings is about 10,000 miles. About 900 miles of the line consists of double track. Of the above route mileage, over 6,000 miles are owned by Government, 300 miles are owned by various private companies, and 430 miles by Indian States. The greater part of the line (6,260 miles) is of broad gauge (5′-6″) the remainder being of 2′-6″. A second map showing the system as it is at present will be found at the end of this article. (Marked 'B').

Over 1,800 miles have been constructed for strategic purposes and these sections are for the most part unremunerative owing to the lightness of the traffic. This, as can readily be realised, has a considerable influence on the working costs of the system as a whole. Another important factor in the same connection is the great distance which separates the line from the sources of fuel supply. Coal, which is used on the greater part of the system has to be hauled all the way from the Bengal Coal Fields, while oil, which is employed on the Karachi Division, comes from the head of the Persian Gulf. Those facts need to be borne in mind when comparing the operating and financial results of the North Western Railway with those of other lines.

The Future.

It might be thought that with the growth of transport facilities described above the requirements of the areas served would have been fully met. This is not the case. The vast irrigation schemes in the Punjab and in Sind which have done so much to develop the fertility of these Provinces are still bringing new tracts under cultivation. Some idea of the influence of irrigation on transport requirements may be obtained from a study of recent developments on the line between Raiwind and Khanewal. 20 years or so ago this area was practically a desert with negligible local traffic Since that date, however, the goods handed per annum at stations on this section have gone up considerably, and this, coupled with the increase in passenger traffic, necessitated the entire remodelling and enlarging of stations at Kot Radha Kishen, Pattoki, Okara, Montgomery, Mian Channu and Chichawatni.

The widespread demand for feeder lines, to give cross connections to open new areas, was met by constructing new branches which added about 600 miles in the last decade.

The Government of India has recently sanctioned a project for constructing a railway line, called the Sind Right Bank Feeder Railway, from Larkana to Jacobabad *via* Garhi Khairo, Usta and Mauladad, a distance of 84 miles. The existing narrow gauge (2′-6″) line from Larkana to Shahdadkot will be converted to broad gauge (5′-6″). The whole narrow gauge line from Larkana to Dodapur is being purchased by the Government of India from the Sind Light Railway Company. The new line is mainly intended to serve the areas recently brought under cultivation by the new canals in Sind.

The earthquake in May, 1935, necessitated reconstruction of most of the buildings at Quetta and at other places in Quetta Division. A heavy reconstruction programme is now in hand involving an expenditure of about 87 lakhs and this will take another two or three years to complete.

Comprehensive improvements in tracks, bridges and station yards have also been recently carried out on the existing lines to meet the requirements of the increased traffic. Various improvements have also lately been effected to increase the capacity of certain sections to bring the line up to the standard required for modern engines with their heavier axle loads.

Administration.

The Headquarters of the Railway are situated at Lahore. At the head of the Administration is the General Manager with three Deputies and their Assistants. The principal officers are the Chief Engineer, Chief Operating Superintendent, Chief Mechanical Engineer, Chief Commercial Manager, Financial Adviser and Chief Accounts Officer, Controller of Stores and Chief Medical and Health Officer, each of whom has his staff of Deputies and other officers. The line is divided into seven divisions with headquarters at Delhi, Ferozepore, Lahore, Rawalpindi, Multan, Karachi and Quetta, at each of which are stationed Divisional Superintendents with extensive powers and a staff of executive officers for the various branches. There are over 1,00,400 employees on the pay rolls exclusive of contractors' labour and with the increase in importance of matters pertaining to staff welfare, a separate branch has been formed for Personnel, which is the chief concern of one of the Deputy General Managers and for which there is a special officer on each Division.

Workshops and Stores.

Few people have any idea of the multifarious activities of the various workshops and depots situated in the area east of Lahore known as Moghalpura. In the beginning of the century the accommodation which then existed for the maintenance of locomotives and rolling stock became insufficient for the rapidly increasing demands, and the present Carriage and Wagon Shops were constructed between 1908 and 1910. In 1909 the new Locomotive Shops were started, and completed in 1914, at a total cost of 50 lakhs of rupees. The accommodation left vacant by the removal of these two shops to their new quarters was utilised for the Signal Engineer's Workshops, which, with the development of safety devices for the control of traffic, had begun to assume considerable importance.

The present Locomotive Shops give occupation to some 4,000 employees, and are capable of thoroughly overhauling 480 engines a year. The Carriage and Wagon Shops employ slightly more (5,000) and have an annual building capacity of 400 four-wheeler units of coaching stock and repair facilities for some 4,000 units of coaching stock and 10,000 goods wagons. Electric power for these shops is controlled from a Power House which is situated close at hand and which contains generating plant of 7600 K. W. total capacity including 6000 K. W. of Turbine plant. Since December, 1934, power is purchased from the Punjab Hydro-Electric Scheme and transformed or converted for distribution, the Railway plant being maintained purely as a standby.

A matallurgical laboratory was installed in the Locomotive Workshop in 1927 ; and in 1934, owing to the constantly increasing volume of work, this was transferred to more spacious quarters in the General Stores building.

The Laboratory is equipped to carry out analyses and physical tests of incoming stores for Controller of Stores, of water supplies for the Engineering and Medical Branches, and the examination of metal failures from all parts of the line in addition to the routine test and control of Workshops' supplies and Foundry production.

The apparatus and plant includes three physical testing machines ; one of 50 tons, one of 20 tons, and one of 200/4000 lbs. capacity, the latter being also adopted for hardness testing ; a power operated Brinell hardness tester ; a Firth's Hardometer with ball and diamond indentors ; a transverse testing machine for cast iron ; an Izod Impact testing machine ; a Scleroscope and Standard Cement testing apparatus There is a Refrigerator for storing volatile reagents during the summer months and for carrying out tests at low temperatures; a completely equipped metallurgical microscope, a high power Leitz instrument for the examination of textiles, food stuffs, paints, etc., a Hilger spectroscope, 2 potentiometers for the determination of PH values and for checking pyrometers, a Zeiss Refractometer, and a Hair Hygrometer for the determination of moisture of stores in bulk.

The Chemical Laboratory, with a staff of 10 graduate chemists and technicians, is equipped to carry out routine analyses of metals and alloys, waters, coal and coke, oils and greases, cement, etc., and the staff also controls the manufacture of certain commodities such as paint-remover, insecticide, and the like, which are used in shops, one chemist being constantly engaged in investigating these and similar problems.

The Metallurgist acts as a general scientific consultant for the whole Railway, and is a member of the recently formed All-India Standing Committee of Railway Chemists and Metallurgists, which meets two or three times a year for the discussion of technical problems under the Chairmanship of the Metallurgical Inspector (Indian Stores Department).

A large area in Moghalpura is occupied by the General Stores Depot with the Office of the District Controller of Stores. The value of material in stock at any one time may be upwards of two crores of rupees, while the turnover during the year approaches eight crores. The large Printing Press which is in the same area employs over 400 men, and some indication of its scope may be gathered from the fact that about a thousand tons of paper are consumed in the year ; while the annual requirements of printed matter include items such as 80 million tickets and 30 million telegraph forms. Mention should also be made of the Clothing Factory which manufactures uniforms for the staff throughout the North Western Railway.

The educational facilities provided at Moghalpura are of some interest. In 1923, the Government of the Punjab, recognizing the necessity of providing technical education for Indians, established the Maclagan Engineering College in the vicinity of shops so that theoretical and practical training could proceed simultaneously. The college is administered by a Governing body of which the Chief Engineer, P. W. D. (R. & B.) is the Head. The course, both theoretical in the college and practical in the shops, lasts 5 years, during which time students obtain a thorough education in all branches of mechanical engineering. There are generally upwards of 200 apprentices in the Carriage and Wagon and Locomotive Shops at any one time. European and Anglo-Indian Apprentices are housed in the Apprentices Home, while Indian Apprentices are accommodated in the college hostel. There are, at present, 694 Trade Apprentices under training in the N. W. Railway Workshops. These apprentices are paid a stipend during the period of their five years' training course, on successful completion of which they are eligible for appointment as Mechanics in the first instance and later as Mistries and Junior Chargemen.

Amenities are provided in Moghalpura in the shape of an Institute, a Recreation and Sports Club, and playing grounds with a hospital in charge of a qualified Medical Officer. Dispensaries are also located within the main workshops to give immediate attention to workmen, who may fall suddenly ill or meet with an accident. There is also a Child Welfare Centre in charge of a qualified Lady Health Visitor at Moghalpura. A Workmen's train runs daily (except Sundays and holidays) between Lahore and Moghalpura—a distance of approximately three miles—which conveys the workmen of the Central Mechanical Workshops, Printing Press and General Stores to and from their work free of any charge. During the breakfast interval workshop employees at Moghalpura are entertained with music by means of Loud Speakers.

The Walton Training School at Lahore Cantonment provides training for new entrants to the subordinate ranks of railway service, except ministerial staff, as well as further training to the staff in different branches of railway work.

The school estate covers an area of 100 acres, and consists of the main school buildings, quarters for the instructional and school staff, and hostels with accommodation for 350 boarders, complete with kitchens and conveniences. There are tube-wells with electric pumps for the supply of water for domestic and irrigation purposes, and an electric transformer for lighting and power. Twenty-five acres of land are set aside for use as a sports ground. The school now provides the North Western Railway with the most up-to-date railway training school in India.

The main school building consists of lecture rooms and model rooms for practical instruction in the various branches of railway working. The transportation model room is equipped with over 400 ft. of 2½ in. gauge single and double line track, electrically operated, with 16 stations and 21 signal cabins, representing in miniature the various types of signalling and train control employed on the open line. The model can accommodate 25 students where facilities exist for practising full size block instruments, the various train operations necessary for Indian Railways. This was described in an Editorial in the Railway Gazette, London (dated 5th March, 1937), as the largest and best equipped transportation model room in India, or, probably, in the East where every system of block-working and signal work is demonstrated on a miniature railway with full-sized instruments.

The Locomotive, Carriage and Wagon, and Telegraph rooms are well-equipped with a full range of models, including a complete set of vacuum gear fittings, valve setting models, various types of ejectors, a condemned engine, and also a complete wagon showing the various deficiencies which take place due to wear and tear, and which the Indian railways are required to repair or replace in order to comply with the foreign interchange rules under the Indian Railway Conference Association.

To meet the needs of way and works apprentices, permanent way inspectors, and others, the school has been provided with various types of rails, crossings, instruments and permanent way equipment enabling students to obtain a thorough and practical training in the correct methods of track construction. These are also used for the training of probationer and student engineers.

Similarly, in the case of commercial staff, the coaching and goods lecture rooms are equipped as model booking offices and goods offices so that the staff can be taught the practical commercial work side by side with the theoretical instruction imparted in the lecture rooms.

Some Remarkable Engineering Works.

No account of the North Western Railway, however short, would be complete without some mention of the great engineering works, which its construction has entailed.

The Indus and its tributaries are rivers liable to heavy floods during the summer months, and the construction of the many bridges across these broad streams has taxed to the utmost the resourcefulness, ingenuity and preseverance of the Railway Engineer. The most imposing structure perhaps is the Lansdowne Bridge at Sukkur with its central span of close on 800 feet. The next largest single span (combined with smaller spans) is that at Khushalgarh where the line crosses the Indus at a point where its waters flow through a narrow gorge. The Empress Bridge at Adamwahan crosses the Sutlej by 16 spans of 250 feet. The Attock Bridge is of interest, not only as an Engineering work, but on account of its historic site.

The art of Railway location in a mountainous country is well exemplified by the lines from Sibi to the steep slopes, often at a gradient of 1 in 25, now leaps the giddy heights of the Chupper Rift and now burrows beneath the barrier of the Khojak Pass till at length it reaches the Frontier station of Chaman. Further north the line through the Khyber Pass, only recently opened, bids fair to become a classic in railway construction of this nature. In its short 26 miles there are 34 tunnels, 92 bridges, and 4 reversing stations, while the skill with which the steep drop from Landi Kotal to Landi Khana is negotiated is particularly instructive.

Nor do the engineering difficulties always end when a section is open to traffic. The necessity of a sufficient supply of water on the desert sections has led to many curious expedients, and the traveller beyond Nushki may sometimes note as many as 6 auxiliary water tanks behind the engine in its long runs between sources of supply. Moving sand-hills are a feature of parts of Sind and the Punjab while even without the formation of these formidable obstacles, the storms are liable in some parts to cover the track and cause derailments unless gangs are constantly at work to clear the drifts.

Movement of Agricultural Produce.

The North Western Railway serves a vast agricultural area comprising the Provinces of the Punjab and Sind. As is to be expected in such an area, the chief commodities which contribute to the goods traffic of the line consist of the products of the soil and it is interesting to note how the development of the various irrigation schemes in these Provinces and improved transport facilities provided by feeder lines had in the past affected the evergrowing quantities of agricultural produce moved by the Railway, a great deal of which found its way to the Port of Karachi for export to foreign countries. In recent years the situation in regard to export has materially altered and with the economic depression the movement in these commodities has fallen off considerably in spite of increased production. Wheat stands first in importance, but there are so many factors affecting the movement and export of this grain that the amount carried fluctuates violently from year to year. In 1901, 6·97 lakhs of tons were moved. This rose to 14·77 lakhs in 1904, fell to 5·96 lakhs in 1908, and in 1912 rose to a record of 17·04 lakhs, a figure which was only approached in 1924-25 when 1691 lakhs of tons were handled.

Primarily on account of the changed situation in the world wheat market and the greatly reduced demand for the Punjab wheat for export to foreign countries, the movement during subsequent years has never been up to the level of 1924-25. The maximum tonnage handled in these years was 12·66 lakh tons in 1930-31 and the lowest was 7·64 lakhs in 1932-33. The quantity moved in 1937-38 was 11 lakh tons.

Turning to gram and pulses, we find that in the first years of the century 1½ to 2 lakh tons were handled yearly. These figures, which also fluctuate considerably, rose to a record in 1918-19, when 9·92 lakhs were handled, the figure for 1924-25 being 6·05. It reached a minimum of 3·26 lakhs in 1930-31 and was 5·13 lakhs in 1937-38 Other grains also similarly increased from ·44 lakh tons in 1901 to 6·59 lakh tons in 1924-25, but have again dropped to ·9 lakh tons in 1937-38. The movement of oil seeds did not increase to the same extent as the above-mentioned commodities, the quantity moved up to 1924-25 varied from 1½ lakh tons to 5 lakhs. After a drop during the depression period it has again increased to 5·34 lakhs in 1937-38. The movement of *jawar* and *bajra* has declined considerably. Between 1901 and 1905 an average of about 1·6 lakh tons was moved annually, while during recent years the maximum quantity moved was ·94 lakh tons in 1928-29, the figure for 1937-38 being ·46 lakhs. When we come to cotton, however, the growth in popularity of this important commodity, and the way in which the Indian product is establishing itself in the world market, may be gauged from the fact that whereas in 1901, ·65 lakh tons were carried, this rose in 1936-37 to a record figure of 4·96 lakh tons and contributed no less than 1·9 crores of rupees to the revenue earnings of the Railway. During 1937-38, the tonnage move has dropped to 3·53 lakhs.

Passenger Traffic.

With regard to passenger traffic, there can be no doubt that the inhabitants of the Punjab and adjacent Provinces have availed themselves of the facilities for travel which the Railway provides. In 1900 about 20 million passengers were carried on a total route mileage for the entire system of between three and four thousand miles. Last year (1937-38) with a route mileage of 6,946 in spite of intensive competition from road motor transport, no less than 69 million people travelled on the system.

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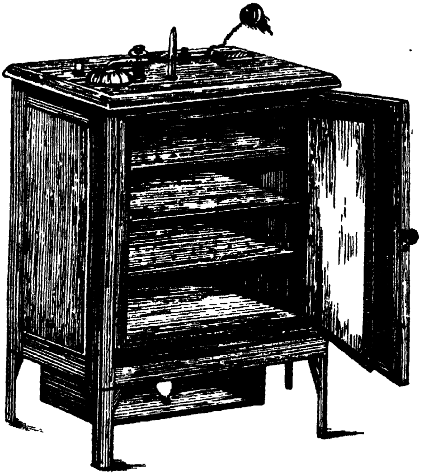

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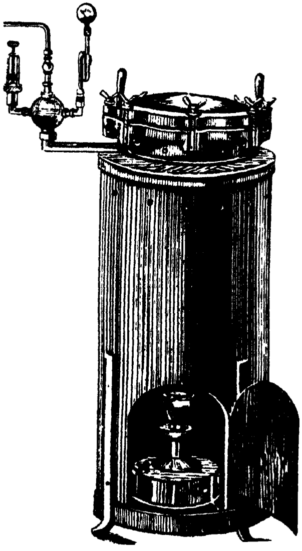

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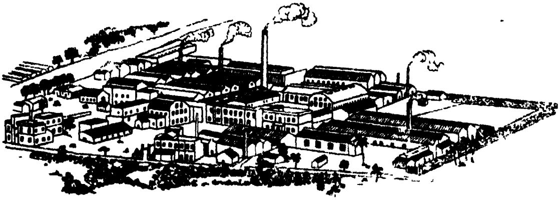

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